[redacted]UE No. 244.

[Superseding No. 140—D.]

Instructions for the Installation and
Operation of

Direct Current
Multipolar Generators and Motors.

Westinghouse Electric & Manufacturing Co.

Pittsburg, Pa.

CATALOGUE No. 244.

[SUPERSEDING No. 140—D.]

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INSTRUCTIONS FOR THE INSTALLATION AND OPERATION OF

Direct Current Multipolar Generators and Motors.

WESTINGHOUSE ELECTRIC & MANUFACTURING CO.

PITTSBURG, PA.

PREFACE

This pamphlet is issued in response to the demand for a "book of instructions" that may help the users of our direct current multipolar machines to a better understanding of the apparatus.

These machines require a minimum amount of care and inspection, but like all machinery having moving parts, a certain amount of intelligent attention is necessary to secure results that will be entirely satisfactory.

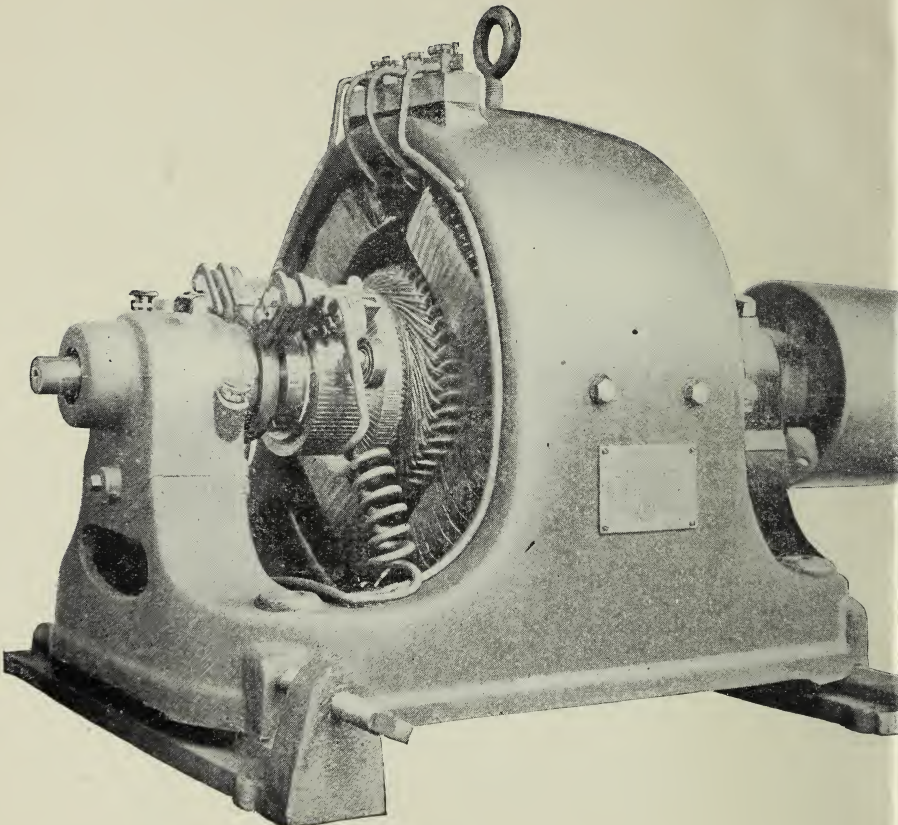
The maxim always to be borne in mind is, keep the machines clean and the bearings well oiled.

Respectfully,

WESTINGHOUSE ELECTRIC & MFG. CO

MARCH 1, 1900.

Table of Contents.



Direct-Current Multipolar Motor.

Multipolar Machines.

Our multipolar generators and motors for lighting and power service are the outcome of our experience and success with our railway generators. All the essential principles of design and construction in the latter class of machines have been combined with the best possible material for producing this line of similar direct current machines.

The illustrations on pages 6, 12 and 18 show the differences in the construction of our larger and smaller machines. In the larger machines (beginning with the 20 H. P. slow speed) the field parts through the center in a horizontal plane; in the smaller machines the field is all in one piece.

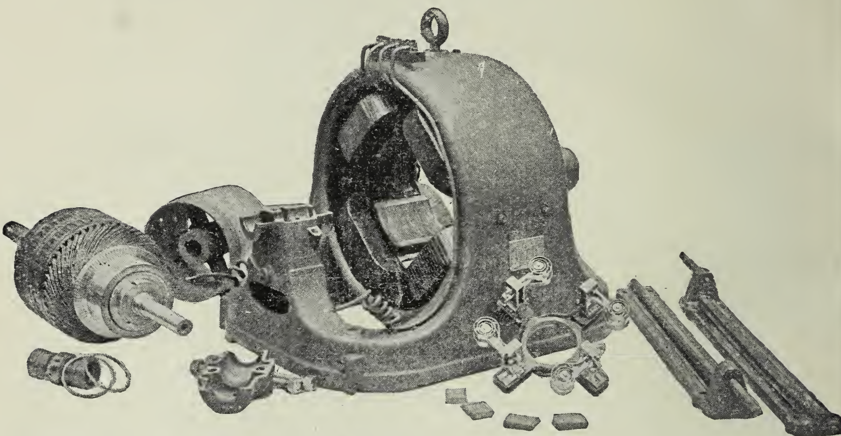
The general form is the one given to all our various lines of electric machinery. The various supports are cast solid with the frame so that there is no possibility of trouble from misaligment. Electrically, this method of construction practically eliminates an external field, so that not only is the efficiency of the machines kept very high, but stray lines of magnetic force are avoided.

The machines are of the multipolar type, having pole pieces of laminated steel cast into the iron yoke. The number of carbon-brush holder arms and the number of carbons per arm depend upon the current of the machine, more arms and a greater number of carbons per arm being used for machines of a larger current.

The bearings are self-aligning and self-oiling. The armatures are of the slotted drum type, and beginning with the 20 H. P. slow speed machine have ventilated discs built up in the core.

The coils are machine wound and so formed as to produce a thoroughly ventilated winding on the armature. They are specially insulated, which protects them from the liability of grounding.

The armature coils are connected to the commutator segments, so as to secure a two circuit winding in all cases, excepting the 100 kw 125-volt machine, which has a multiple winding on the armature.



PARTS OF A MOTOR.

General Information.

The Shunt-Wound Generator is one in which only a portion of the current generated passes through the field windings. The current generated by the armature flows through two paths, one of comparatively low resistance, which is the main circuit, the other of comparatively high resistance, technically known as the shunt, which is the field winding. The voltage of a shunt machine is regulated by varying the total resistance of the field by the use of the rheostat.

A Compound-Wound Machine has two distinct windings on its field magnets, one of very many turns of fine wire, called the shunt winding, and another known as the series winding, which consists of a few turns of comparatively heavy wire. The series winding is in series with the external circuit. The voltage of a generator and the speed of a motor of this type may be regulated within moderate limits by the use of a rheostat in the shunt field circuit. In a generator the effect of the current in the series windings is to cause the magnetism of the field to increase as the load increases, and thus the drop in the voltage, which would otherwise occur by reason of increased drop in the armature winding and the increased magnetic reaction caused by the armature current, is provided for. After the voltage of a compound-wound generator is once adjusted at some definite point, no more hand regulation is necessary, for with a fairly uniform speed the voltage will remain constant. A gen-

erator may be over compounded by having its series winding so increased that the current compensates not only for the drop and reaction in the armature, but also for the drop in the supply circuit. In this case the voltage across the brushes rises as the load increases.

The Shunt=Wound Motor is one in which only a portion of the current supplied passes through the field windings. The current divides and flows through two paths, one of comparatively low resistance, which is the armature, the other of comparatively high resistance, known as the shunt, which is the field circuit.

The Series=Wound Motor is one in which the current utilized by the motor passes successively through the field and armature; or, technically, the field and armature are in series.

In a motor the effect of the series winding is to give the machine a large torque at starting, which, for example, is a necessary qualification for elevator work.

The Output of a generator or the **Input** of a motor may be obtained in watts at any instant by multiplying the current by the voltage as measured at the terminals of the machine. The horse-power may be obtained by dividing the watts by 746.

A Ground on the Line means that the supply circuit —or some of its branch wires—has come in contact with the ground, or with some electrical conductor, which, in turn, is in connection with the ground.

A Ground on the Machine means that some of the field or armature wires have come in contact with the iron frame of the machine by abrasion of the insulation.

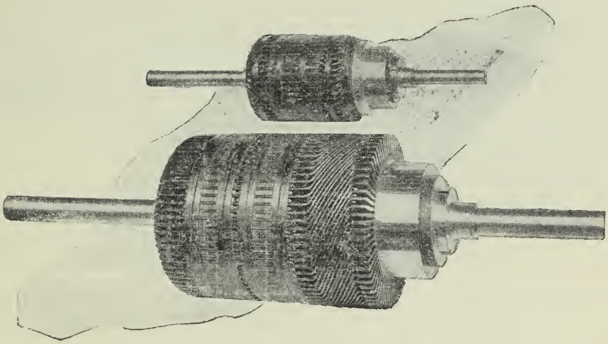
A Short Circuit means that wires have become crossed or connected so as to form a shunt or by-path of com-

paratively small resistance, through which so much of the current passes as to practically cut out that part of the circuit through which the current originally flowed.

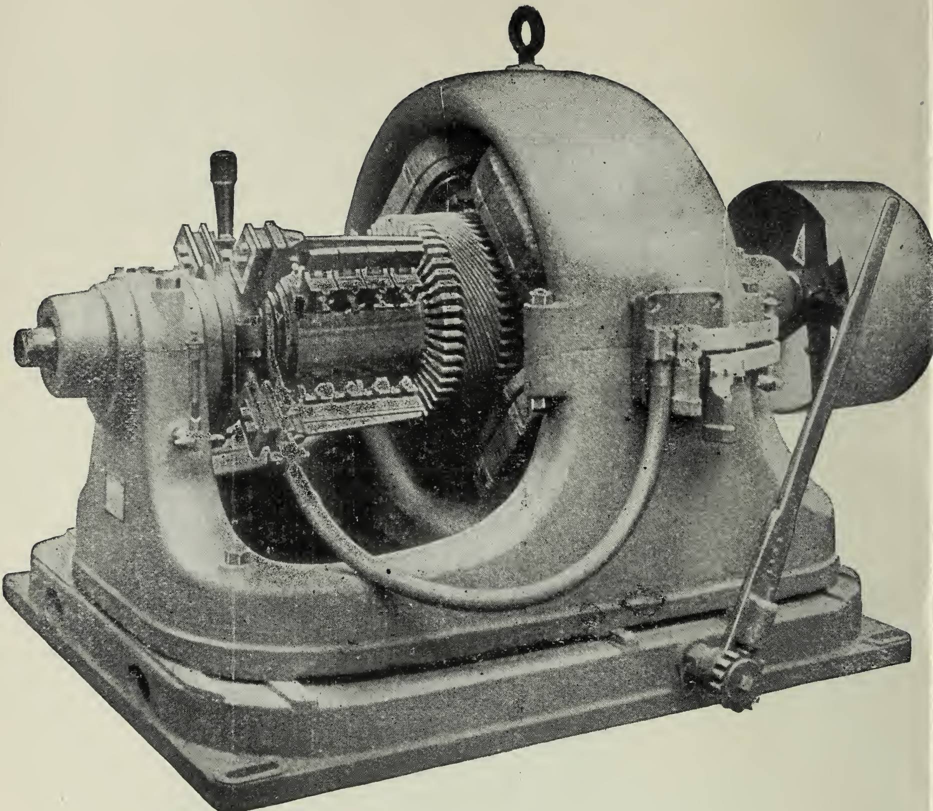
The Point of Commutation means the position on the commutator at which the brushes commutate the armature current without sparking.

The Commercial Efficiency of a Generator or Motor is the quotient obtained by dividing the watts given out by the watts put into the machine, *i. e.*, it is the percentage of the total power applied to the machine which is available for useful work.

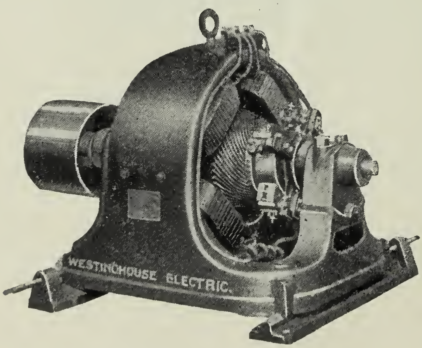
The Positive Brush of a Generator or Motor is often spoken of as the plus and the negative as the minus brush, and they are sometimes marked (+) and (—) respectively.



MULTIPOLAR ARMATURES.



56¼ Kw. 125-Volt Compound Generator.



10 h. p. 125-Volt Shunt Motor.

The Four-Pole Machine.

See Illustrations on pages 6 and 12.

The generators are built with either shunt or compound winding, supplying current at 110-125, 220-250 or 500-550 volts potential, and the motors shunt or compound wound, for 110, 220 and 500 volt circuits.

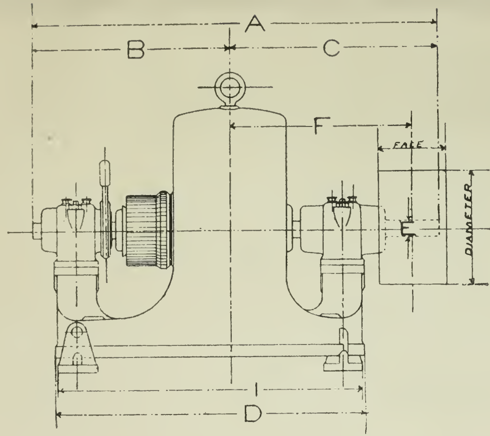
Series-wound motors are furnished when required. The speed, at full load, is somewhat lower than the slow speed motors given in the accompanying table.

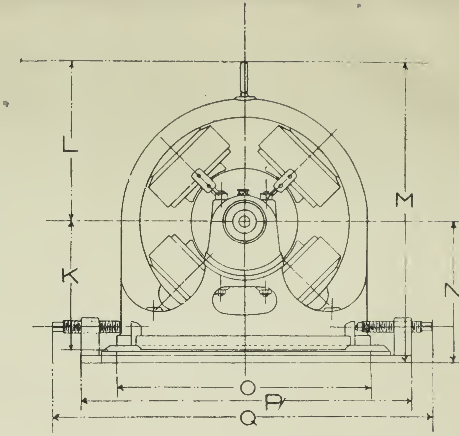
Approximate Dimensions, in Inches, of 4 Pole Machines with Rails.

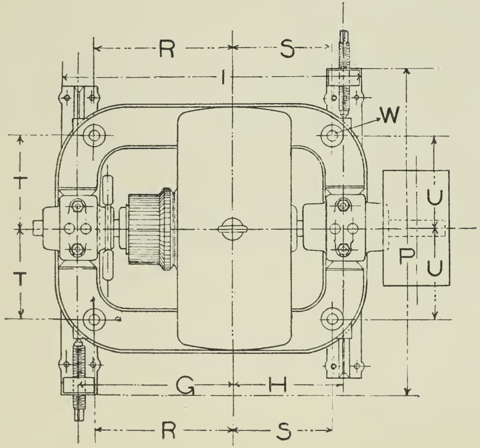
Motors, HP	Generators. KW	Generators. Amp. 125 v.	Generators. Amp. 250 v.	Generators. Amp. 500 v.	Gen. 125 v. Approximate Revs	Motors 110-220 and 500 volts. Generator 250 and 500 volts. Approximate Revs.	A	B	C	D	E	F	G	H	I	K	L	M	N	O	P	Q	R	S	T	U	W Diam. of Bolt-hole.	Pulley. Diam,	Pulley. Face.	Pulley. Length of Hub.	Key-Way in Shaft. Width.	Key-Way in Shaft. Depth.	Average Net Weight. Lbs.
$\frac{3}{4}$	.56	4.5	2.5	1.125	1400	1300	22	11	11	$16\frac{9}{16}$	$\frac{15}{16}$	$9\frac{5}{8}$	$8\frac{1}{2}$	$5\frac{11}{16}$	$16\frac{7}{16}$	$7\frac{1}{8}$	$9\frac{1}{2}$	$17\frac{3}{4}$	$8\frac{1}{4}$	$14\frac{3}{8}$	$20\frac{1}{4}$	23	$7\frac{3}{4}$	5	$5\frac{1}{4}$	$5\frac{1}{4}$	$\frac{9}{16}$	$3\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$\frac{1}{4}$	$\frac{3}{32}$	190
1	.75	6	3	1.5	2000	1900	22	11	11	$16\frac{9}{16}$	$\frac{15}{16}$	$9\frac{5}{8}$	$8\frac{1}{2}$	$5\frac{11}{16}$	$16\frac{7}{16}$	$7\frac{1}{8}$	$9\frac{1}{2}$	$17\frac{3}{4}$	$8\frac{1}{4}$	$14\frac{3}{8}$	$20\frac{1}{4}$	23	$7\frac{3}{4}$	5	$5\frac{1}{4}$	$5\frac{1}{4}$	$\frac{9}{16}$	$3\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$\frac{1}{4}$	$\frac{3}{32}$	190
2	1 50	12	6	3	1300	1200	$26\frac{3}{16}$	$12\frac{1}{2}$	$13\frac{11}{16}$	$19\frac{7}{8}$	$1\frac{3}{16}$	$12\frac{5}{16}$	$9\frac{1}{2}$	$7\frac{1}{2}$	$19\frac{1}{4}$	$7\frac{5}{8}$	10	$18\frac{3}{4}$	$8\frac{3}{4}$	$15\frac{1}{2}$	$20\frac{1}{4}$	$24\frac{1}{2}$	$8\frac{1}{2}$	$6\frac{1}{2}$	$5\frac{3}{4}$	$5\frac{3}{4}$	$\frac{11}{16}$	5	3	$2\frac{1}{2}$	$\frac{5}{16}$	$\frac{7}{64}$	290
$2\frac{1}{2}$	1.875	15	7.5	3.7	1800	1700	$26\frac{3}{16}$	$12\frac{1}{2}$	$13\frac{11}{16}$	$19\frac{7}{8}$	$1\frac{3}{16}$	$12\frac{5}{16}$	$9\frac{1}{2}$	$7\frac{1}{2}$	$19\frac{1}{4}$	$7\frac{5}{8}$	10	$18\frac{3}{4}$	$8\frac{3}{4}$	$15\frac{1}{2}$	$20\frac{1}{4}$	$24\frac{1}{2}$	$8\frac{1}{2}$	$6\frac{1}{2}$	$5\frac{3}{4}$	$5\frac{3}{4}$	$\frac{11}{16}$	5	3	$2\frac{1}{2}$	$\frac{5}{16}$	$\frac{7}{64}$	290
$3\frac{1}{2}$	2 62	21	10.5	5.25	1150	1050	32	$15\frac{3}{4}$	$16\frac{1}{4}$	$24\frac{1}{8}$	$1\frac{7}{16}$	$14\frac{3}{8}$	12	$8\frac{5}{8}$	$23\frac{5}{8}$	$9\frac{3}{8}$	12	$22\frac{7}{8}$	$10\frac{7}{8}$	19	$25\frac{1}{2}$	$30\frac{1}{2}$	$10\frac{3}{4}$	$7\frac{5}{8}$	$6\frac{1}{2}$	$6\frac{3}{4}$	$\frac{11}{16}$	6	4	$3\frac{1}{2}$	$\frac{3}{8}$	$\frac{1}{8}$	550
5	3.75	30	15	7.5	1600	[1]1500	32	$15\frac{3}{4}$	$16\frac{1}{4}$	$24\frac{1}{8}$	$1\frac{7}{16}$	$14\frac{3}{8}$	12	$8\frac{5}{8}$	$23\frac{5}{8}$	$9\frac{3}{8}$	12	$22\frac{7}{8}$	$10\frac{7}{8}$	19	$25\frac{1}{2}$	$30\frac{1}{2}$	$10\frac{3}{4}$	$7\frac{5}{8}$	$6\frac{1}{2}$	$6\frac{3}{4}$	$\frac{11}{16}$	6	4	$3\frac{1}{2}$	$\frac{3}{8}$	$\frac{1}{8}$	550
5	3.75	30	15	7.5	1000	950	36	$16\frac{3}{4}$	$19\frac{1}{4}$	$26\frac{5}{8}$	$1\frac{5}{8}$	$16\frac{7}{8}$	$12\frac{1}{2}$	$10\frac{1}{4}$	$25\frac{3}{4}$	$10\frac{1}{8}$	$12\frac{3}{4}$	$21\frac{3}{8}$	$11\frac{5}{8}$	$20\frac{1}{4}$	$25\frac{1}{2}$	$31\frac{3}{4}$	$11\frac{1}{2}$	$9\frac{1}{4}$	$7\frac{3}{16}$	$7\frac{3}{16}$	$\frac{13}{16}$	8	5	$4\frac{1}{2}$	$\frac{3}{8}$	$\frac{1}{8}$	740
$7\frac{1}{2}$	5 62	45	22 5	11.25	1400	1350	36	$16\frac{3}{4}$	$19\frac{1}{4}$	$26\frac{5}{8}$	$1\frac{5}{8}$	$16\frac{7}{8}$	$12\frac{1}{2}$	$10\frac{1}{4}$	$25\frac{3}{4}$	$10\frac{1}{8}$	$12\frac{3}{4}$	$24\frac{3}{8}$	$11\frac{5}{8}$	$20\frac{1}{4}$	$25\frac{1}{2}$	$31\frac{3}{4}$	$11\frac{1}{2}$	$9\frac{1}{4}$	$7\frac{3}{16}$	$7\frac{3}{16}$	$\frac{13}{16}$	8	5	$4\frac{1}{2}$	$\frac{3}{8}$	$\frac{1}{8}$	740
$7\frac{1}{2}$	5.62	45	22.5	11.25	875	850	38	$18\frac{5}{8}$	$19\frac{3}{8}$	$28\frac{1}{4}$	$1\frac{5}{8}$	17	14	$10\frac{3}{8}$	$28\frac{1}{8}$	$11\frac{1}{8}$	$13\frac{3}{4}$	$26\frac{5}{8}$	$12\frac{7}{8}$	$22\frac{3}{8}$	30	$37\frac{1}{2}$	13	$9\frac{3}{8}$	8	8	$\frac{13}{16}$	8	5	$4\frac{1}{2}$	$\frac{3}{8}$	$\frac{1}{8}$	940
10	7.50	60	30	15	1300	1250	38	$18\frac{5}{8}$	$19\frac{3}{8}$	$28\frac{1}{4}$	$1\frac{5}{8}$	17	14	$10\frac{3}{8}$	$28\frac{1}{8}$	$11\frac{1}{8}$	$13\frac{3}{4}$	$26\frac{5}{8}$	$12\frac{7}{8}$	$22\frac{3}{8}$	30	$37\frac{1}{2}$	13	$9\frac{3}{8}$	8	8	$\frac{13}{16}$	8	5	$4\frac{1}{2}$	$\frac{3}{8}$	$\frac{1}{8}$	940
10	7.50	60	30	15	775	750	$40\frac{3}{4}$	$19\frac{1}{8}$	$21\frac{5}{8}$	$30\frac{1}{8}$	$1\frac{7}{8}$	$18\frac{3}{4}$	$14\frac{1}{2}$	$11\frac{1}{8}$	$29\frac{3}{8}$	$12\frac{1}{2}$	$15\frac{3}{4}$	30	$14\frac{1}{4}$	$25\frac{1}{4}$	35	$39\frac{3}{4}$	$13\frac{1}{8}$	$10\frac{1}{4}$	$8\frac{5}{16}$	$8\frac{3}{4}$	$\frac{13}{16}$	9	6	$5\frac{1}{2}$	$\frac{5}{8}$	$\frac{1}{4}$	1190
15	11.25	90	45	22.5	1200	1150	$40\frac{3}{4}$	$19\frac{1}{8}$	$21\frac{5}{8}$	$30\frac{1}{8}$	$1\frac{7}{8}$	$18\frac{3}{4}$	$14\frac{1}{2}$	$11\frac{1}{8}$	$29\frac{3}{8}$	$12\frac{1}{2}$	$15\frac{3}{4}$	30	$14\frac{1}{4}$	$25\frac{1}{4}$	35	$39\frac{3}{4}$	$13\frac{1}{8}$	$10\frac{1}{4}$	$8\frac{5}{16}$	$8\frac{3}{4}$	$\frac{13}{16}$	9	6	$5\frac{1}{2}$	$\frac{5}{8}$	$\frac{1}{4}$	1190
15	11.25	90	45	22.5	700	650	$44\frac{1}{2}$	$20\frac{7}{8}$	$23\frac{5}{8}$	$32\frac{7}{8}$	$1\frac{7}{8}$	20	$16\frac{1}{2}$	$11\frac{7}{8}$	$32\frac{1}{8}$	$13\frac{3}{4}$	17	$32\frac{1}{2}$	$15\frac{1}{2}$	$27\frac{7}{8}$	35	$41\frac{1}{2}$	$15\frac{1}{4}$	11	$9\frac{1}{8}$	$9\frac{1}{2}$	$\frac{13}{16}$	14	7	$5\frac{1}{2}$	$\frac{5}{8}$	$\frac{1}{4}$	1550
20	15	120	60	30	1050	1050	$44\frac{1}{2}$	$20\frac{7}{8}$	$23\frac{5}{8}$	$32\frac{7}{8}$	$1\frac{7}{8}$	20	$16\frac{1}{2}$	$11\frac{7}{8}$	$32\frac{1}{8}$	$13\frac{3}{4}$	17	$32\frac{1}{2}$	$15\frac{1}{2}$	$27\frac{7}{8}$	35	$41\frac{1}{2}$	$15\frac{1}{4}$	11	$9\frac{1}{8}$	$9\frac{1}{2}$	$\frac{13}{16}$	14	7	$5\frac{1}{2}$	$\frac{5}{8}$	$\frac{1}{4}$	1550
20	15.	120	60	30	600	600	$50\frac{1}{2}$	$25\frac{1}{8}$	$25\frac{3}{8}$	$37\frac{3}{8}$	$2\frac{1}{8}$	22	$19\frac{5}{8}$	$13\frac{1}{4}$	$37\frac{3}{8}$	$15\frac{5}{8}$	$18\frac{7}{8}$	$36\frac{3}{8}$	$17\frac{1}{2}$	$31\frac{3}{4}$	$40\frac{1}{2}$	$50\frac{1}{2}$	$18\frac{5}{8}$	$12\frac{3}{8}$	11	11	$\frac{15}{16}$	14	8	$6\frac{1}{2}$	$\frac{5}{8}$	$\frac{1}{4}$	2460
30	22.5	180	90	45	975	975	$50\frac{1}{2}$	$25\frac{1}{8}$	$25\frac{3}{8}$	$37\frac{3}{8}$	$2\frac{1}{8}$	22	$19\frac{5}{8}$	$13\frac{1}{4}$	$37\frac{3}{8}$	$15\frac{5}{8}$	$18\frac{7}{8}$	$36\frac{3}{8}$	$17\frac{1}{2}$	$31\frac{3}{4}$	$40\frac{1}{2}$	$50\frac{1}{2}$	$18\frac{5}{8}$	$12\frac{3}{8}$	11	11	$\frac{15}{16}$	14	8	$6\frac{1}{2}$	$\frac{5}{8}$	$\frac{1}{4}$	2460
30	22.5	180	90	45	600	575	$56\frac{1}{2}$	$26\frac{5}{8}$	$29\frac{7}{8}$	42	$2\frac{3}{8}$	$26\frac{1}{4}$	21	$15\frac{3}{4}$	$41\frac{1}{4}$	$17\frac{3}{4}$	$21\frac{7}{8}$	$41\frac{1}{2}$	$19\frac{5}{8}$	$36\frac{1}{8}$	$46\frac{1}{2}$	$54\frac{3}{8}$	20	$14\frac{3}{4}$	$12\frac{1}{2}$	$12\frac{1}{2}$	$\frac{15}{16}$	15	11	7	$\frac{5}{8}$	$\frac{1}{4}$	3410
40	30.	240	120	60	950	950	$54\frac{1}{2}$	$25\frac{7}{8}$	$28\frac{5}{8}$	$39\frac{7}{8}$	$2\frac{3}{8}$	$24\frac{7}{8}$	$20\frac{1}{4}$	$14\frac{1}{2}$	$39\frac{1}{4}$	17	$21\frac{7}{8}$	$39\frac{15}{16}$	$18\frac{13}{16}$	$34\frac{1}{2}$	$46\frac{1}{2}$	$52\frac{1}{2}$	$18\frac{3}{4}$	$13\frac{5}{8}$	$11\frac{3}{4}$	$11\frac{3}{4}$	$\frac{15}{16}$	15	11	7	$\frac{9}{16}$	$\frac{3}{16}$	2950
40	30.	240	120	60	550	550	$65\frac{3}{4}$	$34\frac{7}{8}$	$30\frac{7}{8}$	$47\frac{1}{4}$	$2\frac{5}{8}$	$26\frac{3}{4}$	$26\frac{1}{8}$	$15\frac{5}{8}$	$46\frac{1}{4}$	$18\frac{1}{2}$	$23\frac{3}{8}$	$43\frac{5}{8}$	$20\frac{1}{4}$	$37\frac{1}{2}$	$46\frac{1}{2}$	$55\frac{5}{8}$	$25\frac{1}{8}$	$15\frac{5}{8}$	12	12	$\frac{15}{16}$	20	11	8	$\frac{5}{8}$	$\frac{7}{32}$	3900
[2]50	37.5		150	75		900	$56\frac{1}{2}$	$26\frac{5}{8}$	$29\frac{7}{8}$	42	$2\frac{3}{8}$	$26\frac{1}{4}$	21	$15\frac{3}{4}$	$41\frac{1}{4}$	$17\frac{3}{4}$	$21\frac{7}{8}$	$41\frac{1}{2}$	$19\frac{5}{8}$	$36\frac{1}{8}$	$46\frac{1}{2}$	$54\frac{3}{8}$	20	$14\frac{3}{4}$	$12\frac{1}{2}$	$12\frac{1}{2}$	$\frac{15}{16}$	15	11	7	$\frac{5}{8}$	$\frac{1}{4}$	3410
[3]50	37.5	300			900	900	59	$29\frac{1}{8}$	$29\frac{7}{8}$	$44\frac{1}{4}$	$2\frac{3}{8}$	$26\frac{1}{4}$	$23\frac{1}{2}$	$15\frac{3}{4}$	$43\frac{3}{4}$	$17\frac{3}{4}$	$21\frac{7}{8}$	$41\frac{1}{2}$	$19\frac{5}{8}$	$36\frac{1}{8}$	$46\frac{1}{2}$	$54\frac{3}{8}$	$22\frac{1}{2}$	$14\frac{3}{4}$	$12\frac{1}{2}$	$12\frac{1}{2}$	$\frac{15}{16}$	15	11	7	$\frac{5}{8}$	$\frac{1}{4}$	3600
50	37.5	300	150	75	550	550	66	$33\frac{3}{4}$	$32\frac{1}{4}$	$47\frac{7}{8}$	$2\frac{5}{8}$	$28\frac{1}{8}$	$25\frac{3}{8}$	$16\frac{7}{8}$	$46\frac{3}{4}$	19	$23\frac{1}{8}$	44	$20\frac{7}{8}$	$38\frac{3}{4}$	$46\frac{1}{2}$	$55\frac{3}{4}$	$24\frac{3}{8}$	$15\frac{7}{8}$	13	13	$\frac{15}{16}$	20	11	8	$\frac{5}{8}$	$\frac{5}{16}$	4300
60	45.	360	180	90	850	850	$65\frac{3}{4}$	$34\frac{7}{8}$	$30\frac{7}{8}$	$47\frac{1}{4}$	$2\frac{5}{8}$	$26\frac{3}{4}$	$26\frac{1}{8}$	$15\frac{5}{8}$	$46\frac{1}{4}$	$18\frac{1}{2}$	$23\frac{3}{8}$	$43\frac{5}{8}$	$20\frac{1}{4}$	$37\frac{1}{2}$	$46\frac{1}{2}$	$55\frac{5}{8}$	$25\frac{1}{8}$	$15\frac{5}{8}$	12	12	$\frac{15}{16}$	20	11	8	$\frac{5}{8}$	$\frac{7}{32}$	3900
[4]75	56.25		225	112.5		800	66	$33\frac{3}{4}$	$32\frac{1}{4}$	$47\frac{7}{8}$	$2\frac{5}{8}$	$28\frac{1}{8}$	$25\frac{3}{8}$	$16\frac{7}{8}$	$46\frac{3}{4}$	19	$23\frac{1}{8}$	44	$20\frac{7}{8}$	$38\frac{3}{4}$	$46\frac{1}{2}$	$55\frac{3}{4}$	$24\frac{3}{8}$	$15\frac{7}{8}$	13	13	$\frac{15}{16}$	20	11	8	$\frac{5}{8}$	$\frac{5}{16}$	4300

1, Speed of 250 volt Generator is 1600. 2. See next line for 125 volt Generator and 110 volt Motor, 3. 125 volt Generator and 110 volt Motor *only*.

4. See page [illegible] for 75 hp 110 volt Motor.



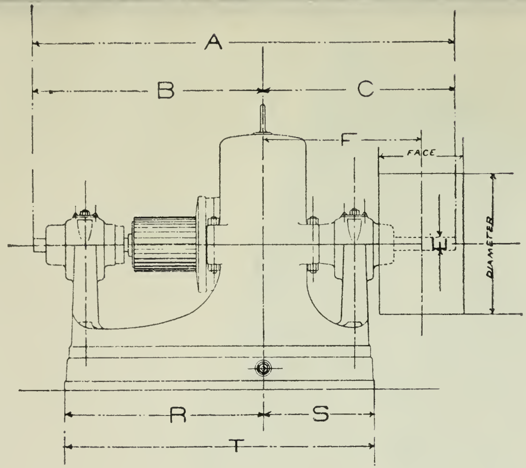


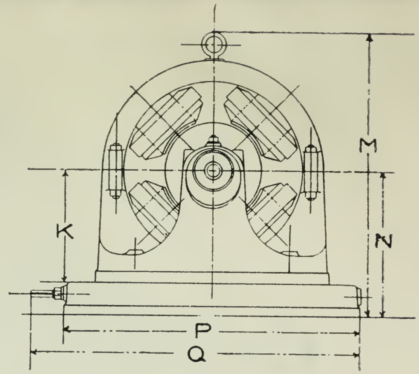


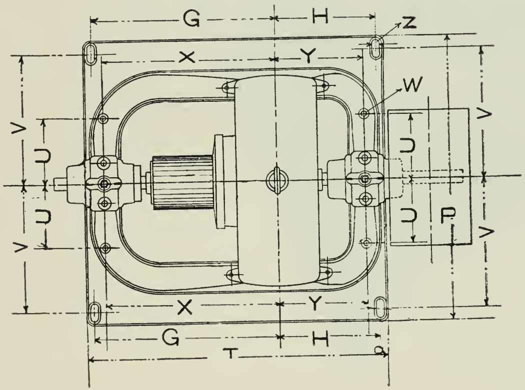
4-POLE MACHINES, WITH RAILS.

Approximate Dimensions in inches of 4-Pole Machines with Bed Plates.

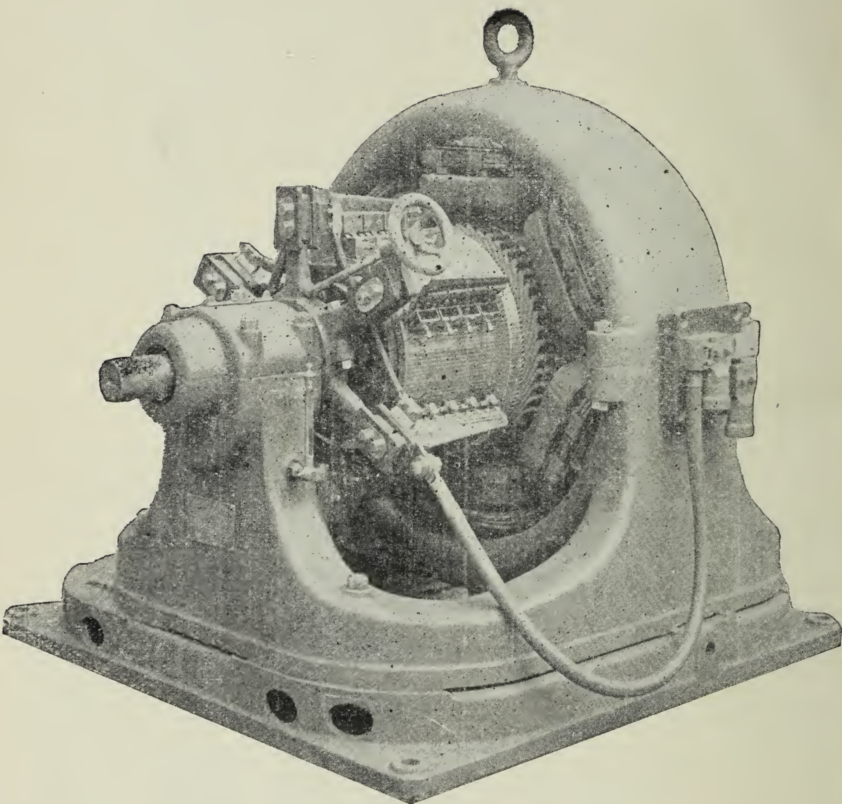
Motors.	Generators.				Motor 110 v. Genr. 125 v.	Motors 220 & 500 v. Genrs 250 v.	Genrs. 550 v.	A	B	C	E	F	G	H	K	M	N	P	Q	R	S	T	U	V	W-Diam. of bolt hole in field casting.	X	Y	Z-Width of bolt hole in bed plate.	Pulley.			Key-way in Shaft.		Average Net Weight Lbs
HP.	KW.	Amp. 125 v.	Amp. 250 v.	Amp 550 v.	Approximate. Revs.	Revs.	Revs.																						Diam.	Face.	Length of Hub	Width	Depth	
75	56.25	450			800			70 3/8	38 1/4	32 1/8	2 5/8	27 7/8	31 3/4	19 1/8	19	47 1/2	24	49 3/4	55	33	20 3/8	53 3/8	13	22 5/8	15/16	28 1/2	15 7/8	1 1/4	20	11	8	5/8	5/16	5270
75	56.25	450			525			77 1/2	42 1/16	34 13/16	2 7/8	29 1/2	35 7/8	19 5/8	21	52	27	55	60 1/4	37 1/8	20 7/8	58	12 1/2	25 1/4	15/16	33 1/4	17	1 1/4	26	12	9	3/4	5/16	6540
75	56.25		225	102.3		525	525	70 7/16	35 17/32	34 29/32	2 7/8	29 1/2	29 1/8	19 5/8	21	52	27	55	60 1/4	30 3/8	20 7/8	51 1/4	12 1/2	25 1/4	15/16	26 1/2	17	1 1/4	23	12	9	3/4	5/16	6220
100	75	600			750			77 1/2	42 1/16	34 13/16	2 7/8	29 1/2	35 7/8	19 5/8	21	52	27	55	60 1/4	37 1/8	20 7/8	58	12 1/2	25 1/4	15/16	33 1/4	17	1 1/4	26	14	9	3/4	5/16	6540
100	75		300	136.4		750	700	70 7/16	35 17/32	34 29/32	2 7/8	29 1/2	29 1/8	19 5/8	21	52	27	55	60 1/4	30 3/8	20 7/8	51 1/4	12 1/2	25 1/4	15/16	26 1/2	17	1 1/4	26	14	9	3/4	5/16	6220







4-POLE MACHINES,
WITH BED PLATE.



100 Kw. Generator.

The Six-Pole Machines.

We illustrate upon the opposite page a 100 Kw. generator.

These machines are compound wound.

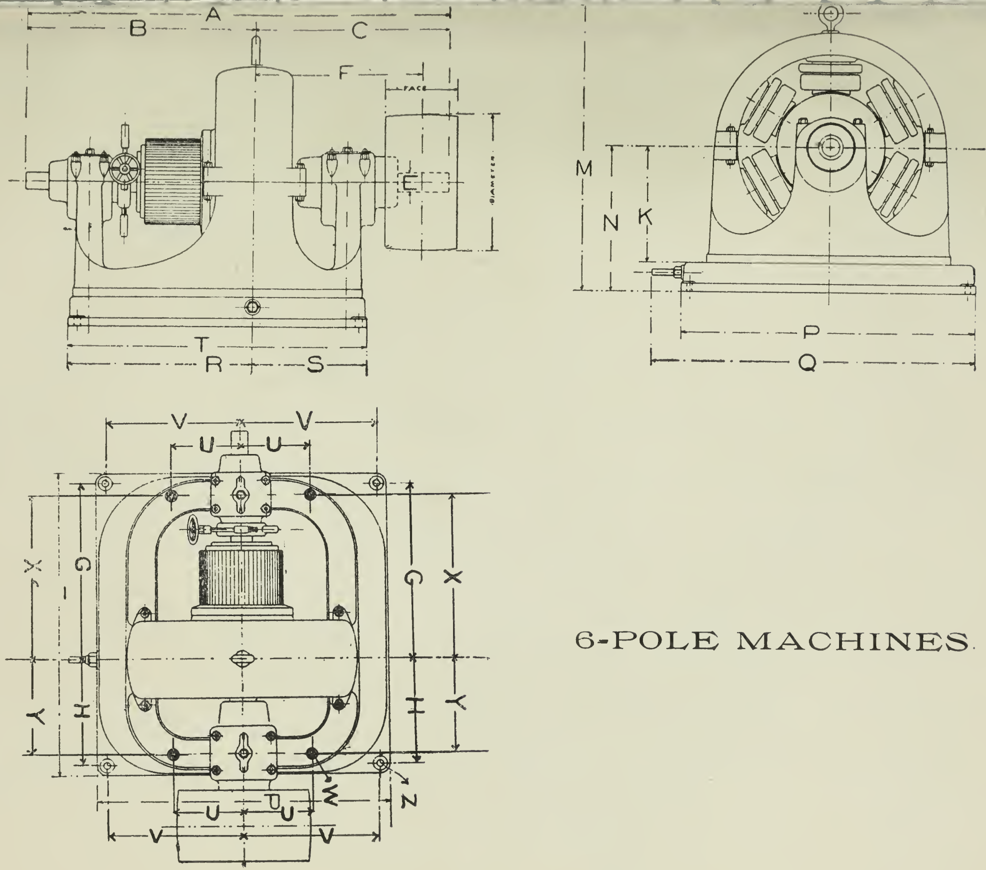
The generators are built for supplying currents at 110–125 or 220–250 volts potential, and the motors for 110 and 220 volt circuits, as per the accompanying tables.

Approximate Dimensions in Inches of 125-Volt, 6-Pole Machines.

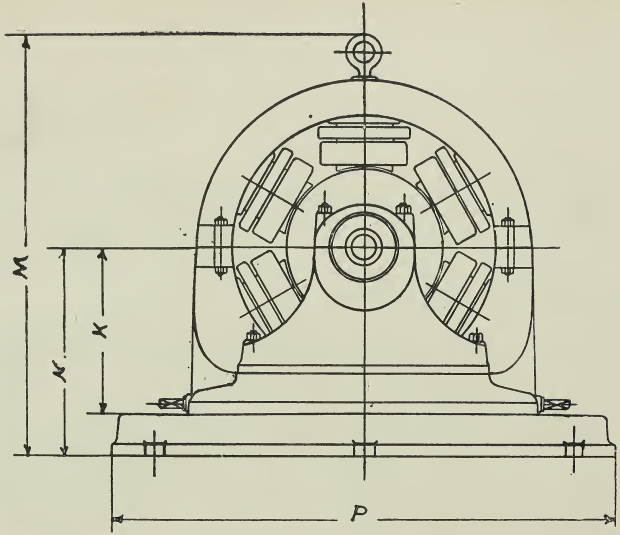
KW.	HP.	Amp.	R.P.M.	A	B	C	E	F	G	H	K	M	N	P	Q	R	S	T	U	V	W-Diam. of bolt hole in field cast'g	X	Y	Z-Width of bolt-hole in bed plate.	Pulley. Diam.	Pulley. Face.	Pulley. Length of Hub.	Key-way in Shaft Width.	Key-way in Shaft Depth.	Weight Net Lbs.
100	134	800	550	$87\frac{9}{16}$	$47\frac{11}{16}$	$39\frac{7}{8}$	$3\frac{7}{8}$	$34\frac{7}{8}$	$36\frac{7}{16}$	$21\frac{7}{8}$	24	$61\frac{1}{8}$	30	61	$66\frac{3}{4}$	$38\frac{7}{16}$	$23\frac{7}{8}$	$62\frac{5}{16}$	15	$28\frac{1}{2}$	$1\frac{1}{8}$	$33\frac{9}{16}$	$19\frac{5}{8}$	$1\frac{1}{2}$	28	16	8	$\frac{7}{8}$	$\frac{3}{8}$	10000
150	201	1200	475	$105\frac{3}{4}$	$57\frac{3}{4}$	48	$4\frac{3}{4}$	39	$45\frac{3}{8}$	$22\frac{3}{8}$	29	$70\frac{1}{4}$	35	$75\frac{1}{2}$	$80\frac{1}{2}$	$48\frac{3}{8}$	$25\frac{3}{8}$	$73\frac{3}{4}$	18	$34\frac{3}{4}$	$1\frac{3}{8}$	42	19	$1\frac{1}{2}$	34	26	16	1	$\frac{3}{8}$	15000

Approximate Dimensions in Inches of 250-Volt, 6-Pole Machine.

KW.	H.P.	Amp.	R.P.M.	A	B	C	E	F	G	H	K	M	N	P	Q	R	S	T	U	V	W-Diam. of bolt hole in field cast'g.	X	Y	Z-Width of bolt hole in bed plate	Pulley. Diam.	Pulley. Face.	Pulley. Length of Hub.	Key-Way in Shaft. Width.	Key-Way in Shaft. Depth.	Weight Net Lbs.
100	134	400	550	$83\frac{3}{4}$	$43\frac{7}{8}$	$39\frac{7}{8}$	$3\frac{7}{8}$	$34\frac{7}{8}$	$32\frac{5}{8}$	$21\frac{7}{8}$	24	$61\frac{1}{8}$	30	61	$66\frac{3}{4}$	$34\frac{5}{8}$	$23\frac{7}{8}$	$58\frac{1}{2}$	15	$28\frac{1}{2}$	$1\frac{1}{8}$	$29\frac{3}{4}$	$19\frac{5}{8}$	$1\frac{1}{2}$	28	16	8	$\frac{7}{8}$	$\frac{3}{8}$	9500
150	201	600	550	$96\frac{1}{4}$	$48\frac{1}{8}$	$48\frac{1}{8}$	$4\frac{3}{4}$	39	$36\frac{3}{4}$	$23\frac{1}{4}$	29	$70\frac{1}{4}$	35	$75\frac{1}{2}$	$81\frac{1}{8}$	$38\frac{7}{8}$	$25\frac{3}{8}$	$64\frac{1}{4}$	18	$34\frac{5}{8}$	$1\frac{3}{8}$	$32\frac{1}{2}$	19	$1\frac{1}{2}$	34	26	16	1	$\frac{3}{8}$	16000
200	268	800	450	116	$56\frac{3}{4}$	$59\frac{1}{4}$	$5\frac{7}{8}$	$47\frac{1}{2}$	$47\frac{3}{8}$	$26\frac{5}{8}$	$32\frac{1}{2}$	78	$38\frac{1}{2}$	82	$87\frac{5}{8}$	$49\frac{7}{8}$	$29\frac{1}{8}$	79	22	$38\frac{1}{2}$	$1\frac{3}{8}$	$42\frac{3}{4}$	22	$1\frac{1}{2}$	45	33	18	$1\frac{9}{16}$	$\frac{9}{16}$	21000



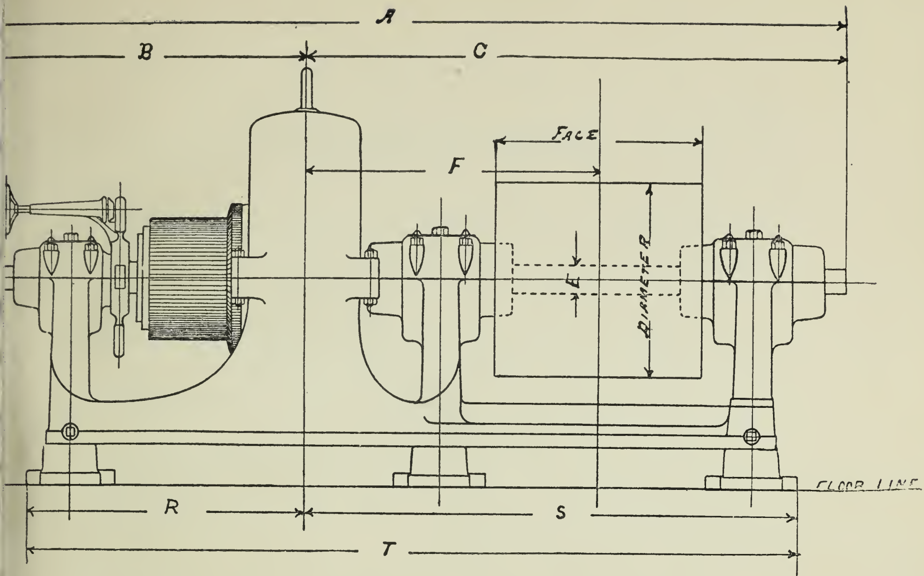
6-POLE MACHINES.



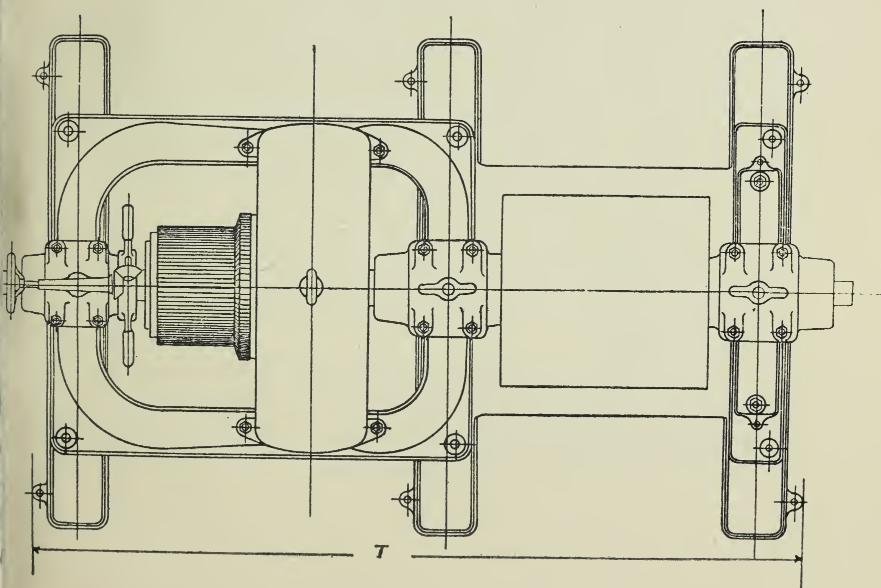
End Elevation of Three-Bearing Generator.

Approximate Dimensions and Weights of 250-Volt, 6-Pole, Three-Bearing Machines.

KW.	Amp.	R.P.M.	A	B	C	E	F	K	M	N	P	R	S	T	Pulley. Diam.	Pulley. Face.	Pulley. Length of Hub.	Key-Way in Shaft. Width.	Key-Way in Shaft. Depth	Weight, Net Lbs.
150	600	550	9′5″	43″	70″	$5\frac{1}{4}$″	$38\frac{1}{4}$″	36″	78″	43″	84″	$40\frac{1}{4}$″	$67\frac{1}{4}$″	$107\frac{1}{2}$″	34″	26″	16″	$1\frac{1}{4}$″	$\frac{7}{16}$″	17,000
250	1,000	420	$12′4\frac{1}{2}$″	$54\frac{5}{8}$″	$93\frac{5}{8}$″	$6\frac{1}{2}$″	$50\frac{1}{2}$″	39″	87″	46″	98″	$49\frac{1}{4}$″	$88\frac{1}{4}$″	$137\frac{1}{2}$″	38″	42″	32″	$1\frac{9}{16}$″	$\frac{9}{16}$″	23,900



SIDE ELEVATION OF THREE-BEARING GENERATOR.



PLAN OF THREE-BEARING GENERATOR.

Setting Up Machines.

Location.—It is very important that the location of machines be wisely chosen, and wherever possible, the following considerations should govern the choice:

First. The machine should not be exposed to moisture, as from dripping pipes or escaping steam.

Second. It should not be exposed to dirt or dust from coal-handling or other causes.

Third. It should be placed in as cool and well ventilated a place as possible. This is important, for a ventilated machine will carry heavy loads and deteriorate less than one unfavorably located.

Foundation.—Machines should be set on substantial foundations, in order to prevent vibration when running. Solid masonry, perhaps, is best for a foundation, but a frame work of timber may be used.

It is well to keep the iron of the machine insulated from the ground, and to this end the bolts securing the machine to its foundation should not come in contact with any other metal or electric conductor. The supports under the machine should be covered with some insulating water-proof paint or compound.

Erecting.—When setting a machine upon its foundation, it should be carefully leveled and the shaft and pulley accurately "lined up" with the driving or driven shaft or pulley.

In shipping the smaller machines the fields are bolted together and properly connected before being shipped. It is only necessary for the purchaser to place the armature in position and make connections.

In erecting the larger machines:

First get the lower half of the field into positoin, then place the armature in its bearings, and after that put on the upper half of the field. In bolting the upper and lower field of the machine together all dirt should be brushed off the surfaces so that contact may be as close as possible, otherwise there will be an unnecessary weakening of the magnetism.

Field Coils.—The coils are machine wound, and in all machines not larger than the 20 H. P. slow speed machines are held in position by metal plates, which are bolted to the yoke. In the larger sizes the plates are bolted to the pole pieces. Field coils should be put into position and properly connected before the armature is put in its bearings. Be particularly careful that the connections between the series coils are made secure and with good contact.

Armature.—Never try to support any of the weight of an armature by the commutator. Do not allow the commutator to rest on any blocking, and do not pass a rope around it for the purpose of lifting the armature. When handling the armature always support it by a rope-sling about the shaft, and never allow it to rest on its body. Be very careful not to mar or scratch the shaft, as any roughness would cause it to cut the bearing and produce heating when running.

In putting the armature in the field be careful not to scratch the bearings, or bend or break the oil rings.

Belts.—Belts must be tight enough to run without slipping, but the tension should not be too great or the bearings will heat. Belts should be run *with*, not *against*, the lapping. The joint should be dressed smooth, so that there will be no jarring of the machine as the cap passes over the pulley. The crowns of driving and driven

pulleys should be alike. The "wabbling" of belts is sometimes due to pulleys having unlike crowns. A wave motion or flapping is usually caused by slipping between a certain portion of the belt and the pulleys, resulting from grease spots etc. The fault may sometimes be corrected by increasing the tension, but the better remedy is to clean the belt. A back and fourth movement of the belt on the pulley is caused by unequal stretching of the edges of the belt.

If the shafts are parallel, but the pulleys not directly opposite, the belt will tend to run more to one or the other side of the larger pulley. If the pulleys are opposite and the shafts not parallel, the belt will run to the side of the smaller pulley.

In lining up two pulleys the shafts should be parallel and the pulleys themselves should be directly opposite each other. Before fastening a machine to its foundation line up the driving and driven pulleys as carefully as possible; put the belt on and run slowly to make sure that the generator or motor is properly placed.

Belts must be quite dry. Where belt-dressing is used it should be applied sparingly.

Bearings.—All our machines have self-oiling bearings, which should be filled to such a height that the rings supply sufficient oil to the shaft to keep it properly lubricated. If the bearings are too full oil will be thrown out along the shaft. Oil in the bearings should be renewed frequently. A warm bearing is usually due to one of the following causes:

(*a*). Excessive belt tension.
(*b*). Failure of rings to revolve with the shaft.
(*c*). Rough bearing surfaces.
(*d*). Bent shaft.
(*e*). Oil too low.
(*f*). Use of a poor grade of oil.
(*g*). End thrust due to improper leveling.

Oil.—Use only the best quality of dynamo oil. It is not economical in the long run to use a cheap quality of oil.

New oil should be run through a strainer if it appears to have any foreign substance in it.

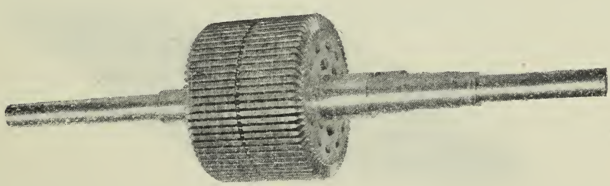
If it is desired to use oil a second time it should be first filtered and given a chance to cool off if it is warm.

Repairs.—If a defect in insulation appears on an armature or the outside of a field coil it can often be repaired by carefully raising the injured wires and putting fresh insulation around them. In the majority of cases, however, repairs require skilled labor and should not be attempted by an inexperienced man.

New Machines.—If the armature and field of a machine have been exposed to dampness or low temperatures they should not be unpacked until they have had ample time to attain a temperature as high as that at which they were packed, *i. e.*, the temperature of an ordinary room.

If possible, a new machine should be run for several hours with the fields slightly charged; this will give it a chance to dry out.

Give the bearings plenty of oil at first, by filling the oil chambers somewhat above the mark on guage.



Multipolar Armature Core.

Instructions for Operating a Single Generator.

(See page 34 for General Instructions for Operating Machines).

STARTING.

First. See that the oil guages show a proper amount of oil in the bearings and that the brushes bear at a point opposite the center of the pole pieces and adjust the spring tension so that the brushes bear properly on the commutator.

Second. Start slowly, and see that the oil rings are revolving freely, then get the machine up to speed.

Third. Raise the voltage to the proper point by throwing resistance out with the hand regulator or field rheostat.

Fourth. Throw in the circuit-breaker and close the switch which connects the generator with the switchboard or the load.

Fifth give the brushes maximum forward lead for maximum voltage on no load, and at that point clamp them, for in this position the machine will carry any load within its rating.

Sixth. Feel all joints and connections, and if any are warm the connection is imperfect and should be remedied.

STOPPING,

First. Throw out all circuit-breakers, then open all switches.

Second. Throw all resistance in with the hand regulator or field rheostat.

Third. Stop engine and thoroughly wipe off all oil and dirt and put in order for next start.

Instructons for Operatng Generators in Multiple.

(See page 34 for General Instructions for Operating Machines.)

To run Compound Generators in multiple it is necessary, in order to have each one do work proportional to its capacity, to connect them in three places—at the regular terminals of the machines and at the beginning of the series windings. The connection from the beginning of the series winding is called the equalizing wire, and runs to the equalizing bar on the switchboard.

On the switchboard the middle one of the three bars is usually the equalizing bar.

Connections.—If the generators are of the same size and make, the only point requiring special attention is that the wires which run from the different machines to the equalizing bar must be the *same size and length* (that is, *of the same resistance*), and also those wires which connect the terminals of the series coils with their bar on the switchboard must have *equal resistance.*

If the generators differ in design or size the matter becomes more complicated. In this case *the difference of potential or drop in voltage, between that end of the series coil which is connected directly to one of the brushes, and the bus bar, to which the other end of that same series coil is connected, should be exactly the same for every generator, when each is carrying its proper share of the load.*

To make this drop the same for each generator, it will be necessary to put resistance in circuit with the series coils of the machines whose drop is least.

The equalizing wires must have as little resistance as is practicable, and never more than the dynamo leads.

In the case of large machines, it takes several hours for the field coils to reach a constant temperature. As the fields heat up it becomes necessary to throw resistance *out* of the shunt circuit.

Trouble is sometimes experienced in getting the load to divide properly between two or more generators, because no attention has been given to this matter of adjustment, which should be undertaken only by expert electricians, who will find no difficulty in running our generators in multiple with machines of any make, and, with the majority of them, perfectly.

STARTING.

If there is one generator, A, furnishing current to the line, and it is desired to throw another one, B, on the same circuit:

First. Get B up to full speed.

Second. Adjust voltage of B as near that of A as possible.

Third. Throw in B's three-jaw switch.

Fourth. Notice the ammeters to see that the loads are rightly proportioned, If A is doing more than its share

of work, throw resistance *in* with its regulator, or *out* with B's regulator. If B is doing too much work, throw the regulator in the opposite direction.

If you want to throw in a third, fourth or fifth machine, follow the same rule.

If a generator is thrown in multiple with another one before its voltage is up to the same point, it will not do its share of the work and may even run as a motor with current from the other machine. In this case, throw resistance *out* with the regulator of machine which has just been thrown on the circuit.

When two machines are working together, if the belt on one of them should break, or slip off, this generator will continue to run, being driven by the other one.

If it is found that the machines do not operate together satisfactorily, note the positions of the brushes. If one machine carries too much of the load move the brushes slightly forward, if too little, backward, without causing them to begin sparking.

STOPPING.

First. Throw resistance *in* with the regulator of the generator to be cut out until its load is very small, as shown by ammeter.

Second. Open circuit-breaker and then three-jaw switch belonging to this generator.

Third. Stop engine or loosen friction clutch.

Be very careful that the shunt circuit of a generator is not opened or broken while it is working in multiple with another one. In case this should happen, the armature or series coils of one or both machines would be burnt out, unless they were almost instantly cut apart by the melting of the fuses, or opening of a circuit-breaker.

If it becomes necessary to raise or lower the voltage on the line, raise or lower the voltage of *all* the machines which are supplying the current.

Instructions for Operating Shunt Motors.

STARTING.

See page 34 for General Instructions for Operating Machines.

First. See that the oil guages show a proper amount of oil in the bearings, and that the brushes bear on the commutator at a point opposite the center of the pole pieces.

Second. If there is a circuit-breaker, close it and then the main switch. Great care should be taken not to open the field circuit, even while the motor is not running, as there is danger of breaking down the insulation of the field if the circuit is suddenly broken. If it is absolutely necessary to break the field circuit it should be done very slowly, allowing the arc thus formed to die out gradually.

Third. Rotate the handle of the automatic starting and stopping rheostat slowly as far as it will go, and hold it in this position until the magnet becomes sufficiently strong to hold the lever. When it is desired to run the motor at variable speeds, a special resistance box will be required.

Fourth. Move the brushes slowly backward till sparking ceases, give them maximum backward lead for no load, then set the rocker arm once for all by securing it in this position.

Fifth, Occasionally feel all bearings, joints and contacts, and if they are unduly warm there is a defect which should be immediately remedied.

STOPPING.

First. Open circuit-breaker or switch which will cut in the resistance of the automatic starting and stopping rheostat.

Never attempt to stop a motor by forcibly pulling open the automatic box. Disregard of this may cause burning out of the field coils.

Second. Clean up and be ready for next start.

Instructions for Operating Series and Compound Wound Motors.

(See page 34 for General Instructions for Operating Machines.)

The speed of these motors is usually regulated by the use of a commutator type controller. The controller consists of a box of resistance material by means of which a voltage of varying intensity is applied to the motor armature, and thus varying speeds and corresponding outputs are obtained.

General Instructions for Operating Machines.

The machines must always be kept dry.—Water dripping on the commutator or armature will cause trouble. At all times keep the machines clean and free from oil and dirt. Carbon dust must be cleaned off frequently, as it is detrimental to the durability of the machine. Be especially careful to see that no oil or dirt collects about the brush holder or commutator. Do not let oil run out of the bearings down on the field winding, as then it collects dirt and will sooner or later result in grounding the winding. All switches should be left open when a machine is not running. Keep all small pieces of iron, such as bolts and tools, away from the machine, as they may fall on the commutator or armature and do damage. If an automatic circuit-breaker is used, it should be adjusted to break at a number of amperes, say 50 per cent. greater than the rated capacity of the machine. If a fuse blows, or if the circuit-breaker acts, first open switch on corresponding line, close the breaker, try it and close again, or replace fuse and afterwards close the switch and, if a motor, start as usual. If the breaker or fuse immediately opens the circuit again, there is something wrong, either a short circuit or overload. As a rule never break the shunt current of a machine, for the inductive discharge from the fine field winding would seriously strain the insulation; perhaps destroy it. In case a short circuit should occur at or near the generator, or if an arc should be formed at a switch or fuse block and hold on, throw all resistance in with field rheostat, and, if necessary, shut

down engine at once. If it should be necessary to remove a brush while the generator is running, do so very carefully, being first certain that the other brushes in the same holder are making contact with the commutator. In case of a hot bearing, first feed heavy lubricant copiously, then slacken the belt, and if relief is not thus afforded shut down, keeping the armature revolving slowly, if practicable, until cool, in order to prevent its sticking.

Commutator.—This is an important part of the machine, and requires careful attention.

Its surface should be kept smooth. If roughened, use No. 00 sand paper occasionally, which may be applied at a point midway between the pole pieces while the commutator revolves slowly. Do not use emery cloth. Ordinarily the commutator only requires to be wiped off with a piece of canvas.

Keep the commutator lubricated by using a very small quantity of oil applied with a piece of cloth. Do not use waste.

See that there is no looseness of any of the parts of the commutator.

If the commutator should get "out of true" it will be necessary to turn it down. This can be done either while the armature is in its bearings, using a special slide rest and running very slowly, or by putting the armature in a lathe.

Flat spots or "flats" sometimes occur on commutators. They are usually caused by excessive wear, by too much end play, by a loose commutator, or by a bad belt splice. A bad short circuit on the line will sometimes produce a flash which will start a "flat."

Commutators, after long usage and much wear, will sometimes get hot when carrying only the regular load

of the machine. This usually indicates that they are worn down as far as it is safe to go, and the commutator should be replaced by a new one.

Brushes.—All the multipolar machines use carbon brushes.

The positions of the brushes of a D. C. machine should be on or near the no-load neutral point of the commutator.

The no-load neutral point on all of our standard multipolar machines is in line with the center of the poles. Generators should have the brushes set a little in advance, and motors which are to run in only one direction should have the brushes set a little back of this point. The exact position in either case is that which gives the best commutation at normal voltage for all loads. In no case should the brushes be set so far from the neutral point as to cause dangerous sparking at no-load. Motors which are to run in either direction should have the brushes set at the no-load neutral point.

The ends of all the brushes should be fitted to the commutator. This can be done by putting them in position in the brush holder and grinding in as shown in illustration on opposite page.

The edge of copper plated brushes should be slightly beveled so that the copper does not come in contact with the commutator.

Brushes on machines having "Swivel Type" holders should be adjusted as follows:

Adjust brush arms so that all are equally distant from commutator face.

Adjust carbons in holders so that stops will allow $\frac{1}{8}$ in. to $\frac{3}{16}$ in. wear on the heels of the carbons.

Grind in carbons with sand paper, as shown in illustration until good fit on commutator is obtained.

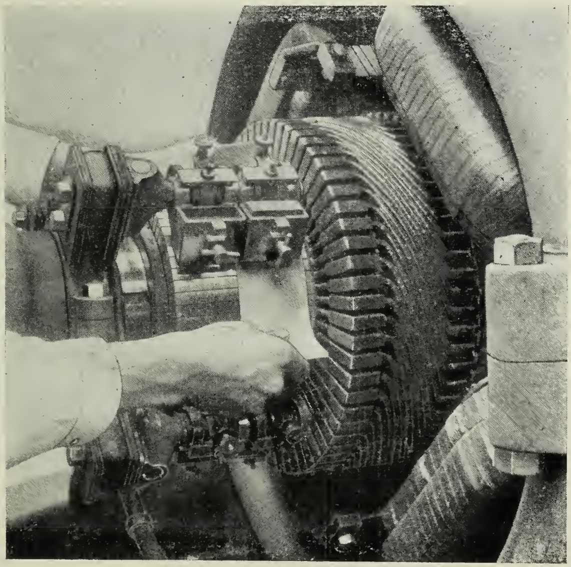
The number of commutator bars between the heels of the carbons under two adjacent poles, should equal total number of commutator bars divided by the number of poles.

Sparking.—Sparking at the brushes may be due to any of the following causes:

(*a.*) Brushes may not be set exactly at the point of commutation. A position can always be found where there is no appreciable sparking; at this point the brushes should be set and secured.

(*b.*) Brushes may be wedged in the holder.

(*c.*) Brushes may not be fitted to the circumference of the commutator.



GRINDING IN CARBONS—"SWIVEL TYPE" HOLDERS.

(*d.*) Brushes may not have sufficient pressure on commutator.

(*e.*) Brushes may be burned on their ends.

(*f.*) Commutator may be rough; if so, it should be smoothed off. The commutator should run smooth and true, with a dark glossy surface.

(*g.*) A commutator bar may be loose or projecting beyond the others.

(*h.*) The commutator may be dirty, oily or worn out.

(*i.*) Machine may be overloaded.

These are the most common causes of sparking, but it may also be due to an open circuit or loose connection in the armature, which will cause a bright spark which will appear to run completely around the commutator. It may be recognized by a scarring of the commutator at the point of open circuit.

Grounds.—Grounds may occur on the feeders or supply circuit wires or on the armature of the machine it self. In order to determine in what part of the system the ground is located, proceed as follows:

Connect in series one, two or five 100-volt incandescent lamps, depending on the voltage of the machine. Touch one of the resulting terminals to a good ground and the other first to the positive and then to the negative brush. If the lamp or lamps light, there is a ground on the feeders. Repeating the same operation, only touching the terminal to the iron frame work of the machine intsead of to the ground, grounding of the armature or field conductors is determined. A ground on the machine is a rare occurrence.

Polarity.—Our generators are so designed that the series winding is connected to the positive brush. If the machine has four brush holder arms and the direction of rotation is clockwise when viewed from the commutator

end, the top brush to the left and the bottom one to the right will be positive, and should be connected together and to the series coil. (See diagrams on pages 43 and 44.) If, however, rotation is in the opposite direction, the other brush will be positive and the connections to the brushes must be reversed. The connections for the six-pole generators are shown in the diagrams on page 45. Any doubt as to the polarity of the brushes of a generator may be determined by the use of a Weston voltmeter. When the polarity of the various parts of a generator have once been determined they should be marked.

Direction of Rotation.—All our machines may be run equally well in either directions. When changing direction of rotation of a 4-pole generator or motor, change connections by connecting the wire which was on the positive brush to what was the negative brush, and the wire which was on the negative brush to what was the positive brush. When changing the direction of rotation of a 6-pole generator, follow directions given in Fig. III, page 45. If the carbon brushes are radial to the commutator the holders do not ordinarly need to be reversed for change in direction of rotation. But in case the carbons are at an angle to the radius of the commutator, the carbon holders should be reversed.

Excitation.—A motor may fail to have its field magnets excited, or a generator may fail to "excite" itself; that is, to generate enough current to charge its own field magnets. This may occur even when the generator was all right the day before. The reason will generally be found to be a loose connection, break in the field circuit or possibly poor contact at the brushes due to a dirty commutator. An open circuit in the field winding can sometimes be traced with a magneto bell, but this is not an infallible test, as all magnetos will not ring through a

shunt winding, even though it be perfect. The trouble may be in the starting box or rheostat. Examine all connections and look for a broken or burned resistance coil. If no open circuit is found here, or in the field, the trouble is probably in the armature. If nothing is wrong with the connections or windings, it may be necessary to excite the fields of the generator from another machine. Calling the generator which will not excite, No. 1, and the other generator from which we are to draw current, No. 2, then, to excite the fields of generator No. 1: *Open all switches and remove brushes of No. 1.* Connect positive brush-holder of No. 1 with the same brush-holder of No. 2, also connect negative brush-holders together (it is well to have about a 5-ampere fuse in circuit), then turn on the current. If the shunt winding of No. 1 is all right, its field will show considerable magnetism. If possible, reduce the voltage of No. 2 before breaking connections. If this cannot be done throw all resistance in with regulator of No. 1 and then break connection *very slowly*, lengthening out the arc which will be formed until it breaks. If it is impossible to obtain current from a second generator, this exciting can be done with a strong battery, by connecting the carbon or copper plate of the battery to the positive brush-holder of the dynamo and the other plate with the negative brush-holder. If there is no second machine or battery at hand, connect the leads from the brushes of the machine through a long fuse of not more than 15 or 20 amperes capacity and then start the machine. If it does not generate current enough to melt this fuse, you may be certain there is something wrong with the armature; either a short circuit or an open circuit. If it does blow this fuse, try again to get it to self-excite. If it does not now build up, something is wrong with the shunt winding, or connection. These remarks apply to machines which have been giving current and then refuse to do so.

If it is a new machine which refuses to excite when the connections all seem to be right, reverse the connections, that is, connect the wire which is on the positive brush to the negative brush and the negative one to the positive brush. If this does no good change them back and locate the fault as described above.

Diagrams.

Figures I to XX on pages 43 to 59 show our standard wiring diagrams. Each diagram is accompanied by a brief explanation.

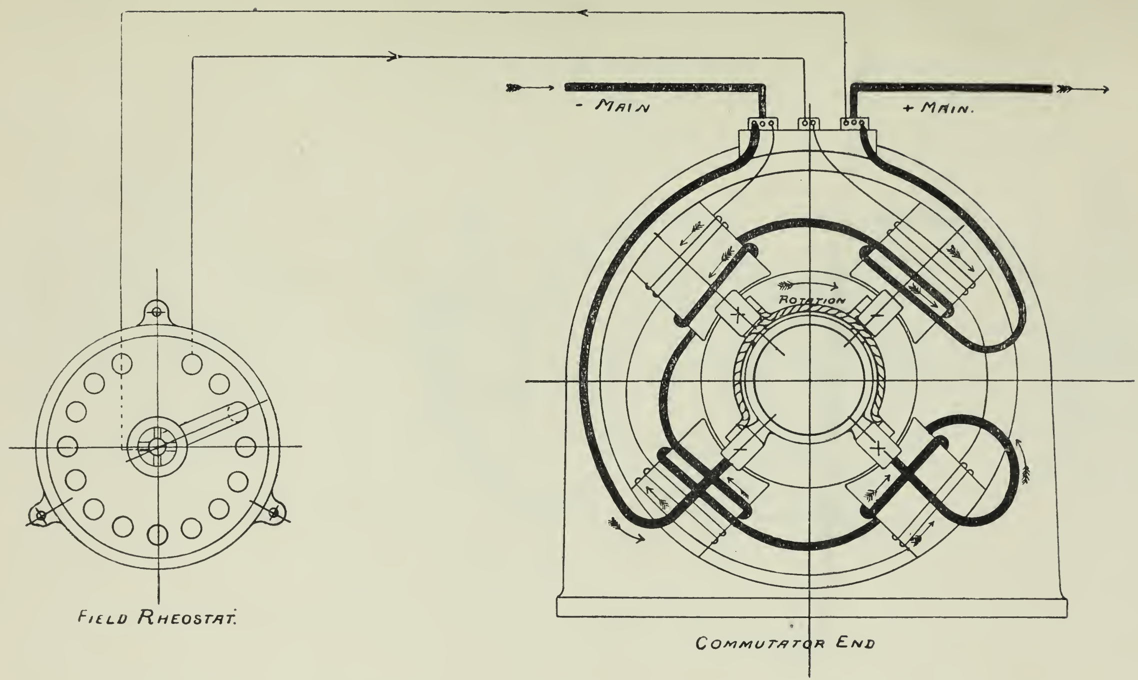


FIG. 1.—COMPOUND-WOUND GENERATOR, 4 POLES, 20 H. P. STANDARD SPEED AND SMALLER.

NOTE—To change direction of rotation, follow instructions on page 39.

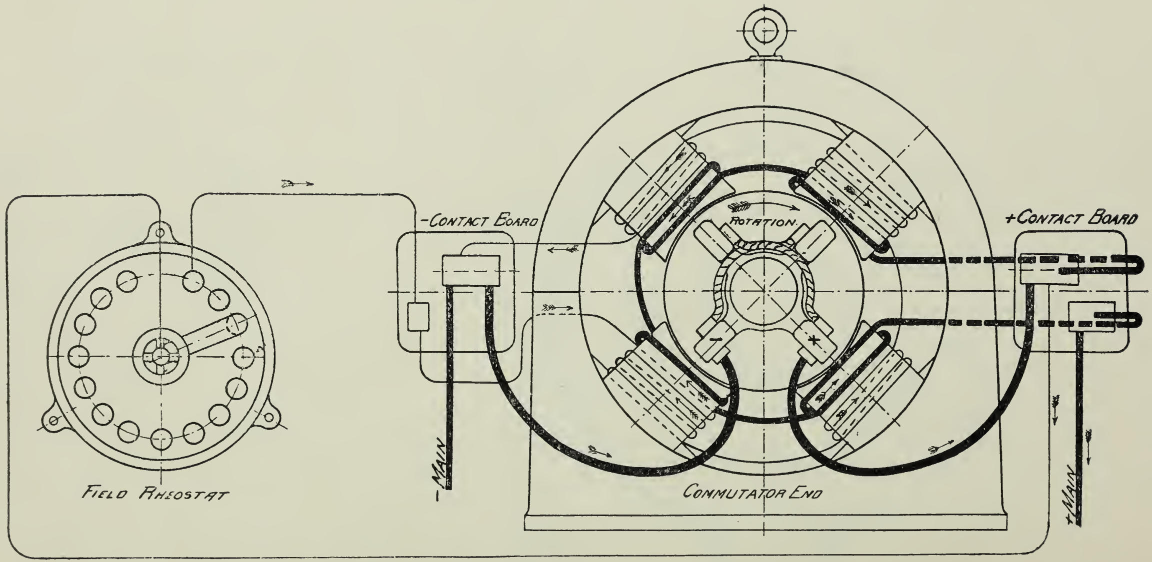
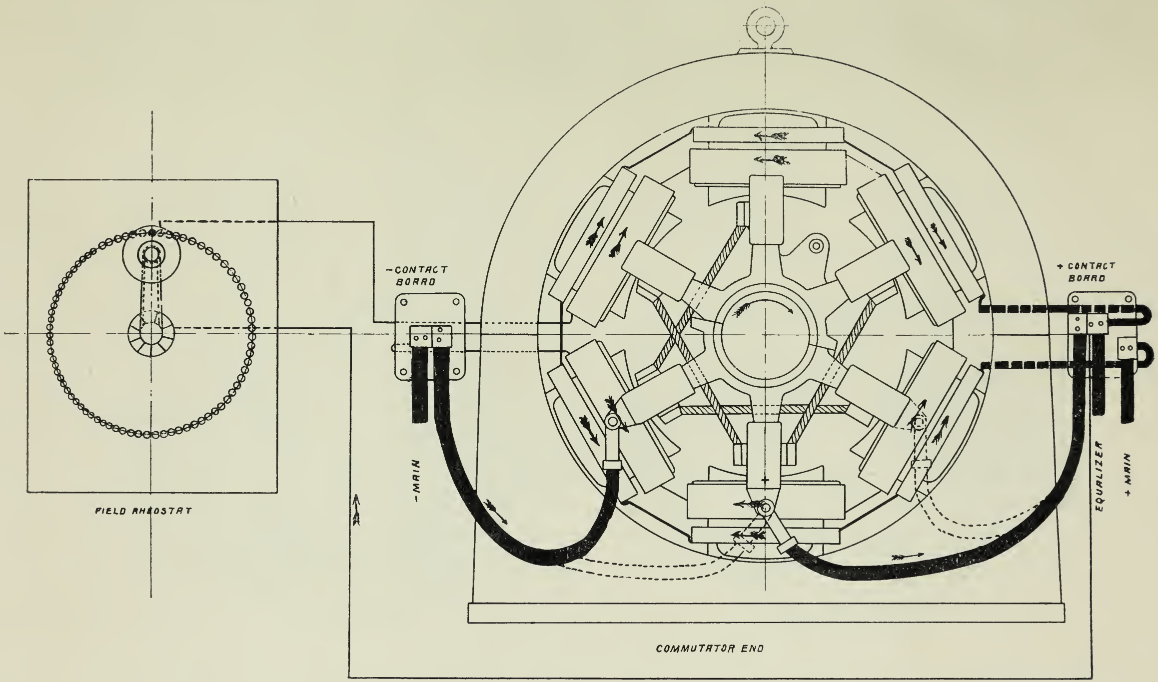


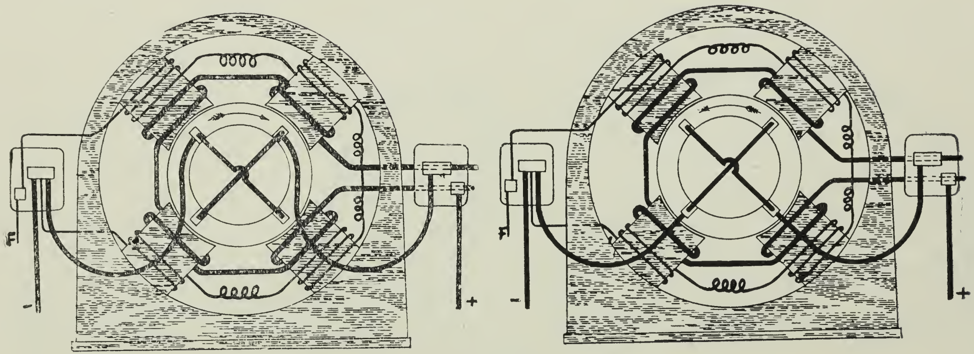
Fig. II.—Compound-Wound Generator, 4 Poles. 20 h. p. Slow Speed and Larger.

Note.—To change direction of rotation, follow instructions on page 39.



NOTE - FOR LEFT HAND ROTATION REVERSE CARBON HOLDERS AND MOVE ROCKER ARM UNTIL TERMINALS ARE IN DOTTED POSITION.

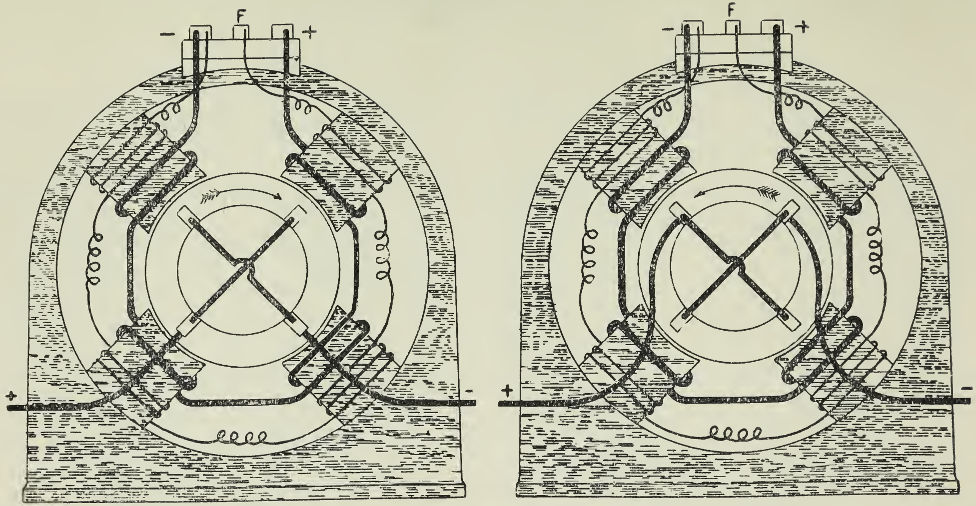
FIG. III.—COMPOUND-WOUND GENERATOR, 6 POLES, 100 TO 200 KW. INCLUSIVE.



CLOCKWISE. COUNTER-CLOCKWISE.

VIEWED FROM COMMUTATOR END.

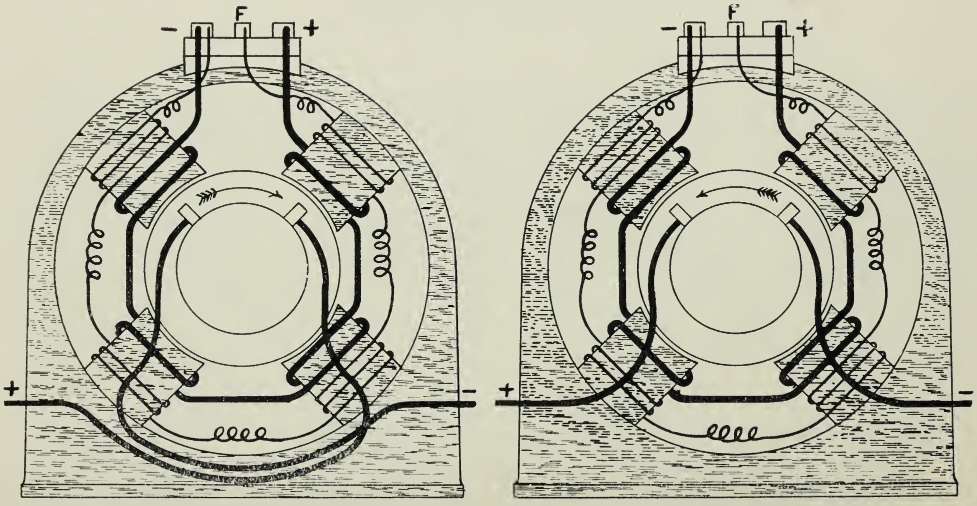
FIG, IV.—COMPOUND-WOUND MOTOR, 4-POLES, 20 H. P. SLOW SPEED AND LARGER.



CLOCKWISE. COUNTER-CLOCKWISE.

VIEWED FROM COMMUTATOR END.

FIG. V.—COMPOUND-WOUND MOTOR, 4-POLES, 20 H. P., STANDARD SPEED AND SMALLER.



Clockwise. Counter-Clockwise.

Viewed from Commutator End

Fig. VI.—Compound Wound Motor, 4-Poles, 20 h. p Standard Speed and Smaller.

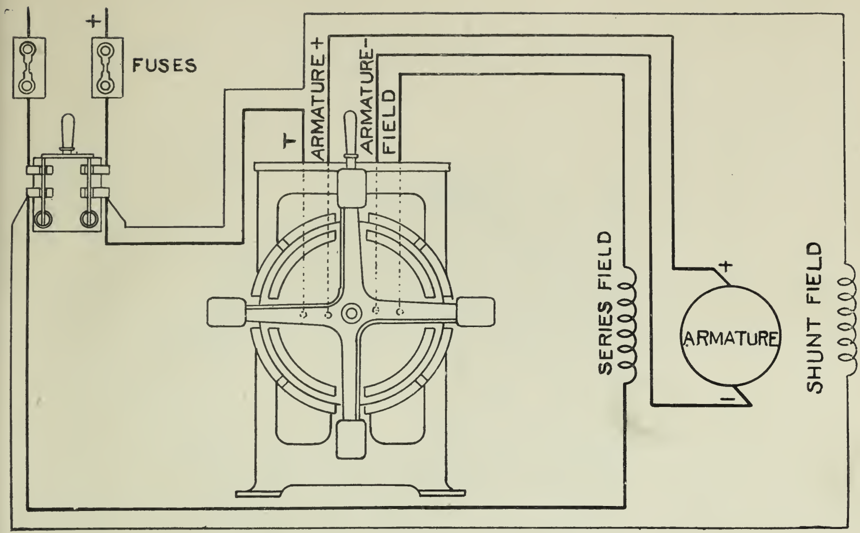


FIG. VII.—COMMUTATOR TYPE CONTROLLER AND DIRECT-CURRENT COMPOUND MOTOR.

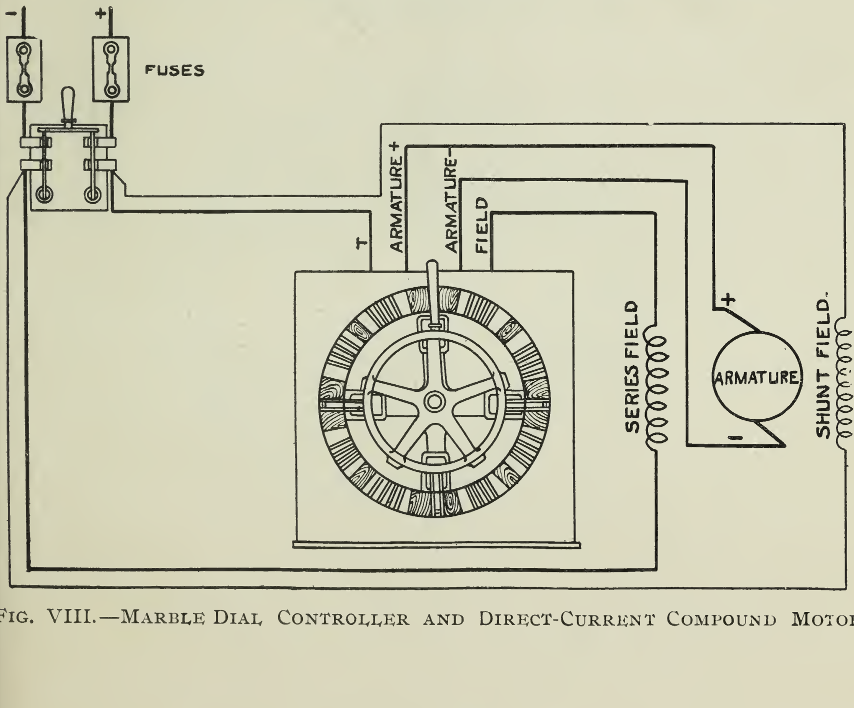
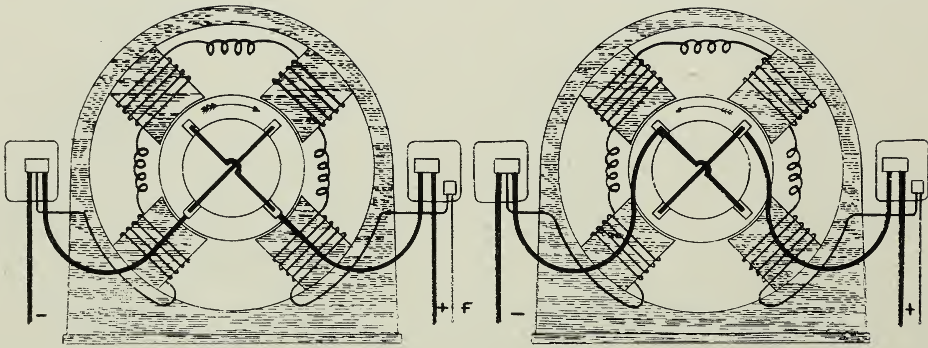


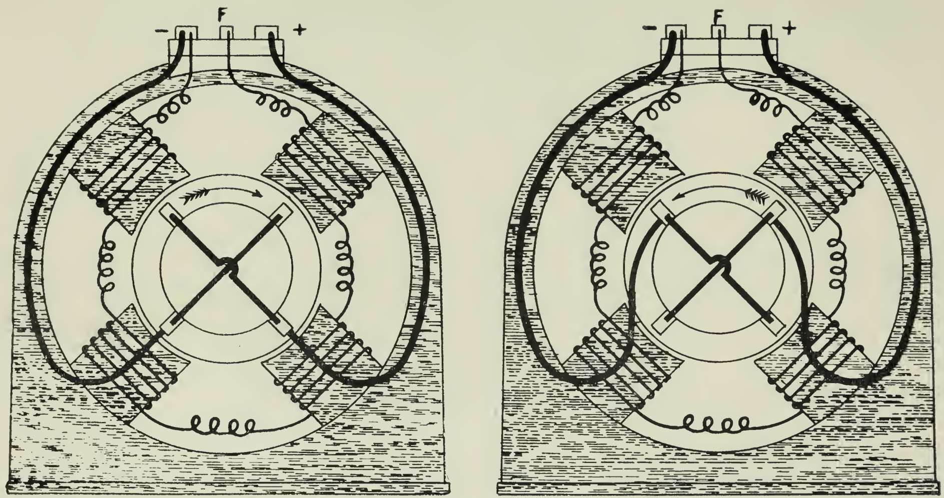
FIG. VIII.—MARBLE DIAL CONTROLLER AND DIRECT-CURRENT COMPOUND MOTOR.



CLOCKWISE. COUNTER-CLOCKWISE.

VIEWED FROM COMMUTATOR END.

FIG. IX.—SHUNT-WOUND GENERATOR OR MOTOR, 4-POLES. 20 H. P SLOW SPEED AND LARGER.



CLOCKWISE. COUNTER-CLOCKWISE.

VIEWED FROM COMMUTATOR END.

FIG. X.—SHUNT-WOUND GENERATOR, OR MOTOR, 4-POLES, 20 H. P., STANDARD SPEED & SMALLER.

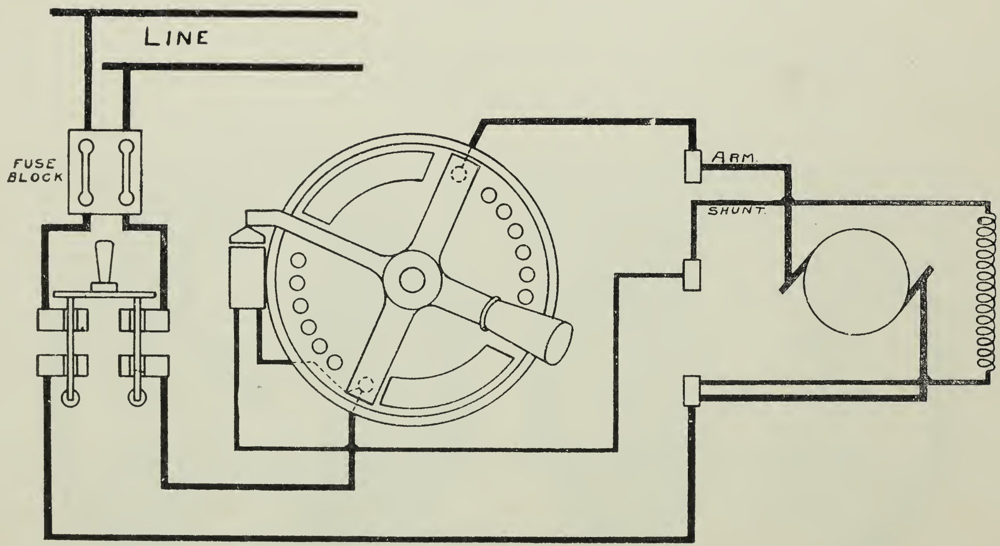


FIG XI.—DIAGRAM FOR SHUNT MOTORS BELOW 15 H. P.

To Start Motor.—Throw in double-pole switch or circuit-breaker. Turn the handle of the starting-box slowly as far as it will go. Hold it in this position until magnet becomes strong enough to hold the lever.

To Stop Motor.—Open double-pole switch or circuit-breaker; the rheostat will act automatically.

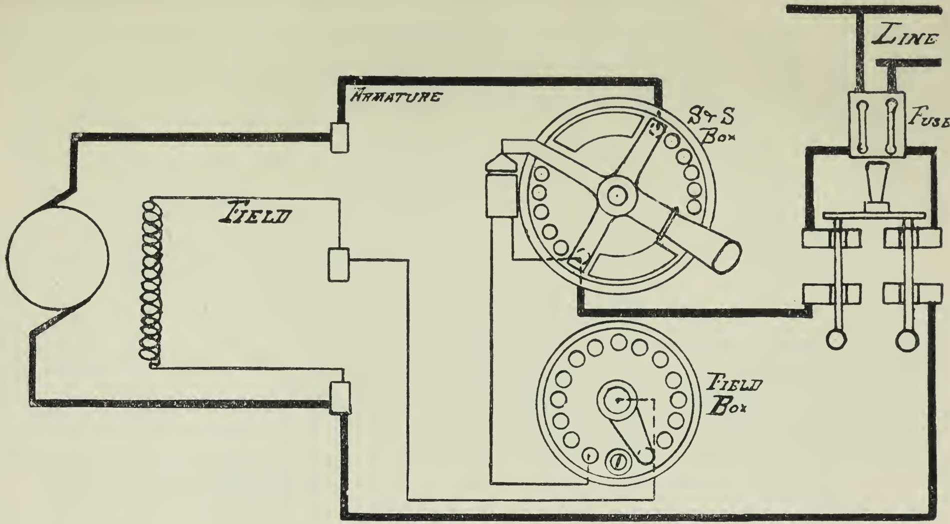


FIG. XII.—DIAGRAM FOR SHUNT MOTORS 15 H. P. AND LARGER.

To Start Motor.—Turn the handle of the field box as far as possible in a direction opposite to the hands of a watch. Throw in double-pole switch or circuit-breaker. Turn the handle of the S. & S. box slowly as far as it will go. Hold in this position until the magnet becomes strong enough to hold the lever. Bring the motor up to the desired speed by turning the handle of the field box.

To Stop Motor.—Open double-pole switch or circuit-breaker; the S. & S. box will act automatically.

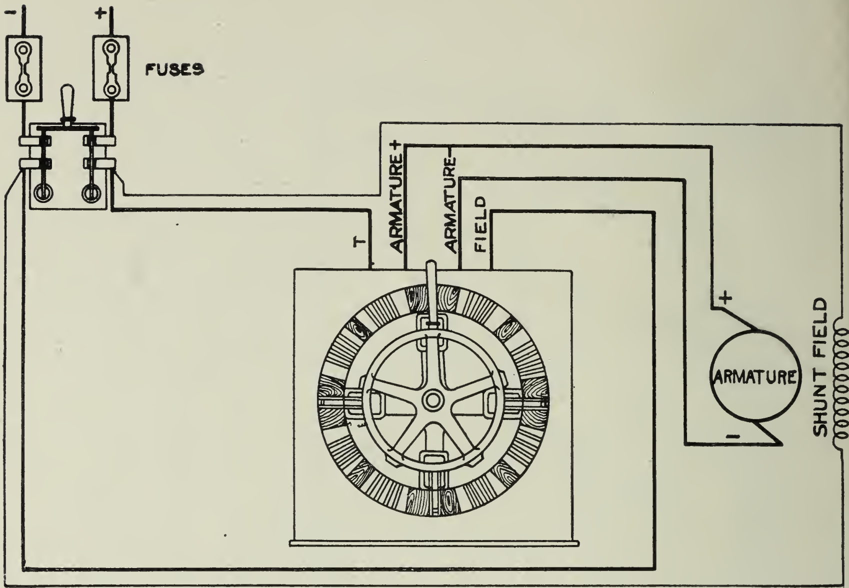


FIG. XIII.—MARBLE DIAL CONTROLLER AND DIRECT-CURRENT SHUNT MOTOR

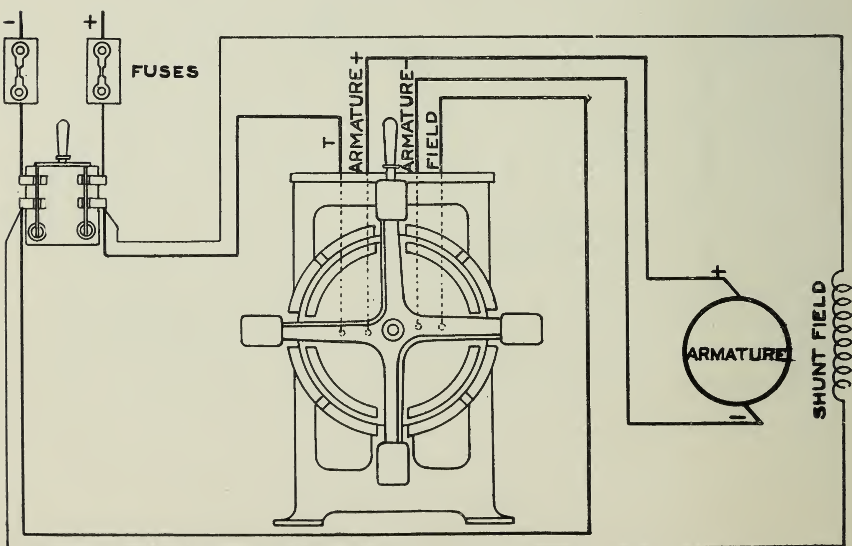
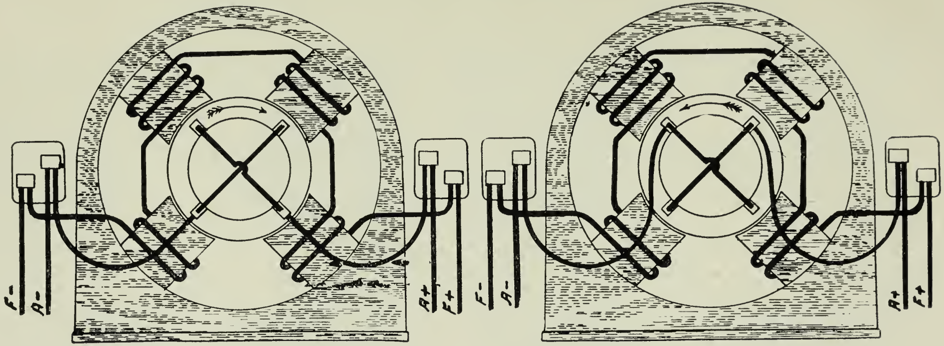


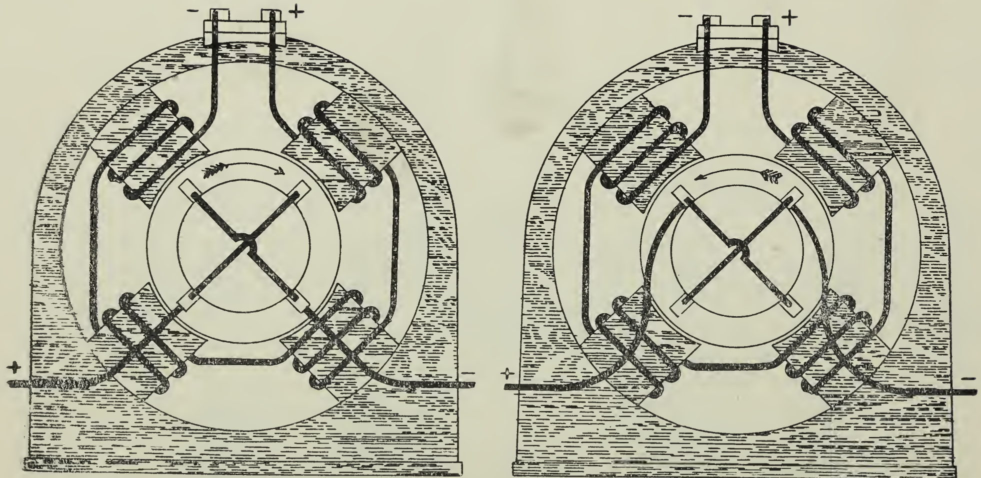
FIG. XIV.—COMMUTATOR TYPE CONTROLLER AND DIRECT-CURRENT SHUNT MOTOR.



CLOCKWISE. COUNTER-CLOCKWISE.

VIEWED FROM COMMUTATOR END.

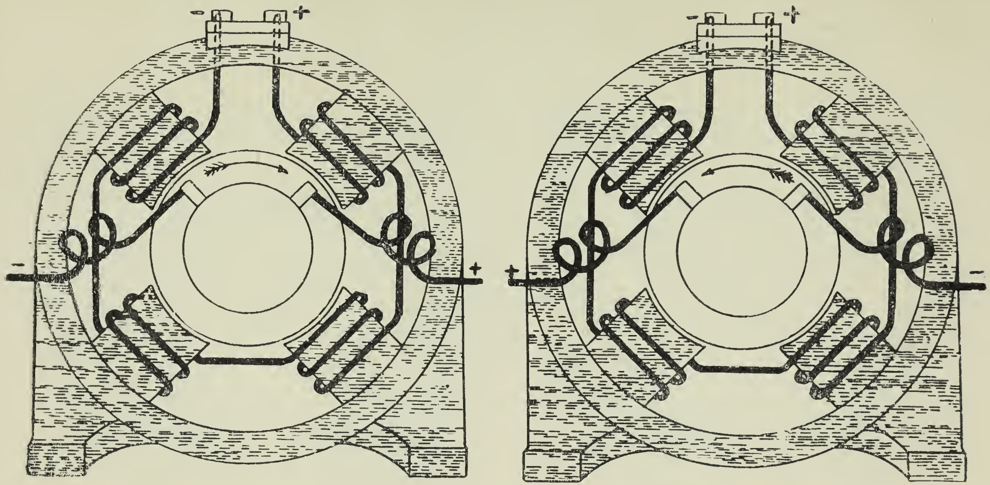
FIG. XV.—SERIES-WOUND MOTOR, 4-POLES, 20 H. P., SLOW SPEED AND LARGER.



CLOCKWISE. COUNTER-CLOCKWISE.

VIEWED FROM COMMUTATOR END.

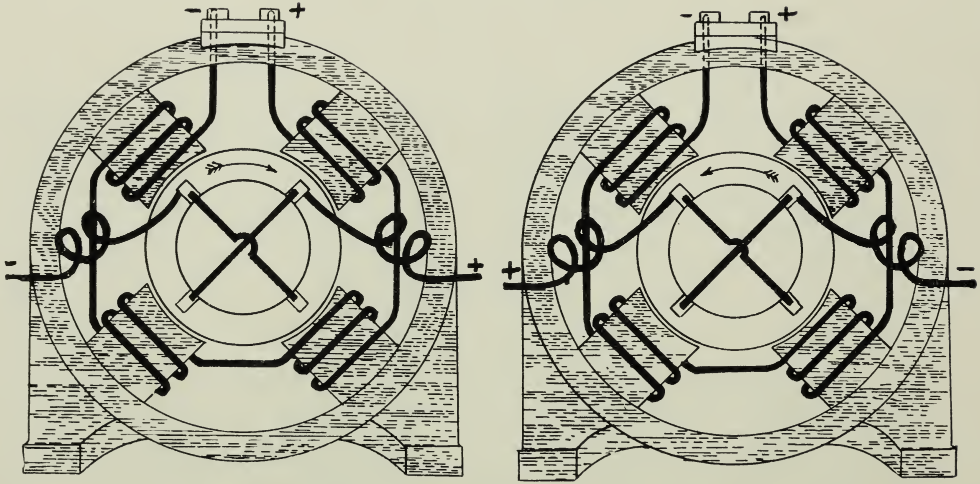
FIG. XVI.—SERIES WOUND MOTOR, 4-POLES, 20 H. P., STANDARD SPEED AND SMALLER.



CLOCKWISE. COUNTER-CLOCKWISE.

VIEWED FROM COMMUTATOR END.

FIG. XVII.—DUST-PROOF SERIES-WOUND MOTOR.



CLOCKWISE. COUNTER-CLOCKWISE.

VIEWED FROM COMMUTATOR END.

FIG. XVIII.—DUST-PROOF SERIES-WOUND MOTOR.

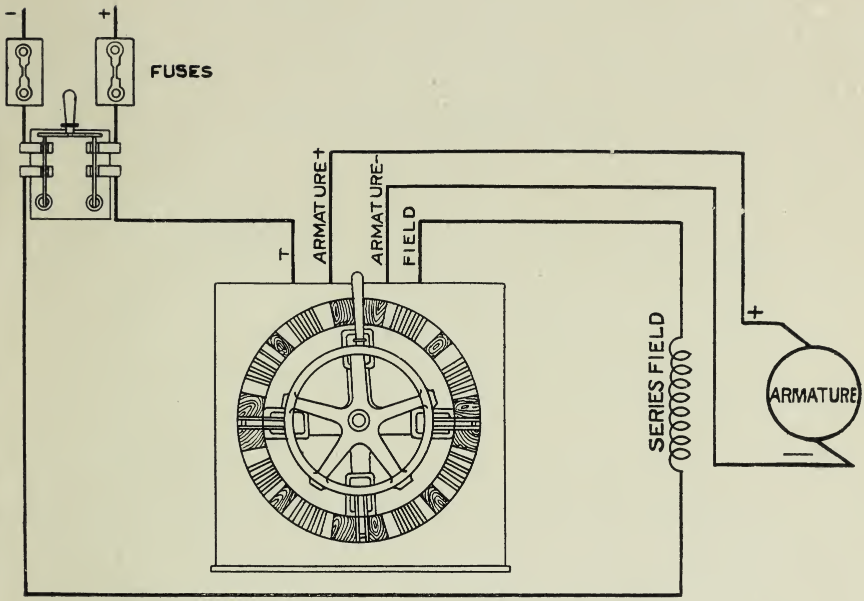


Fig. XIX.—Marble Dial Controller and Direct-Current Series Motor.

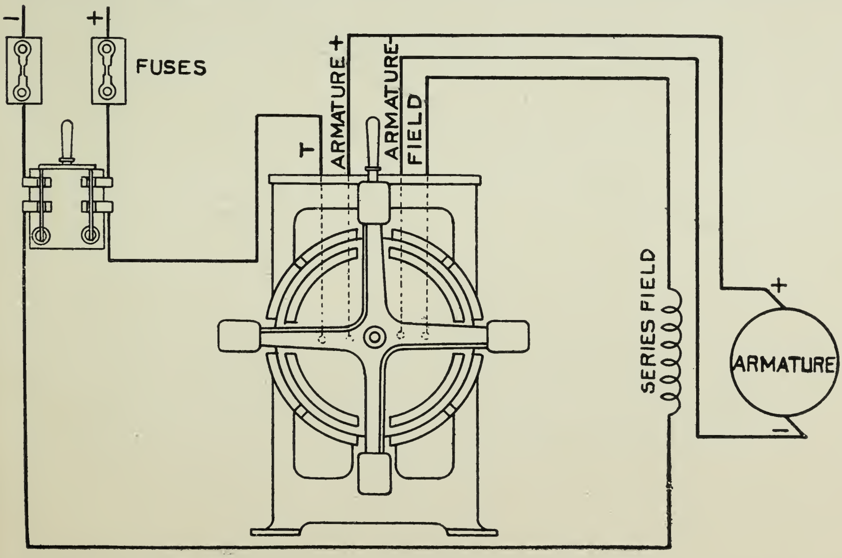


Fig. XX.—Commutator Type Controller and Direct-Current Series Motor.

Switchboard Apparatus.

The Voltmeter shows the voltage or potential, that is, the potential difference between the wires of a circuit or the brushes of a dynamo or motor. All our direct-current voltmeters are so constructed that the current must always pass through them in the same direction, and they have one binding post marked +, which must always be connected to the positive wire or brush.

The Ammeter, or Ampere Meter, is used to measure the quantity of current flowing in the circuit in which it is connected.

Switches are of various kinds, among them the single or double jaw, for ordinary use; the triple jaw, for throwing generators in multiple; the dynamo changing, for transferring machines from one circuit to another, or circuits from one machine to another.

Fuses are strips of lead or other readily fusible metal or alloy, which are placed in the circuit at one or more points. If the current increases above the rated capacity of the fuse it will melt and thereby open the circuit. Fuses are usually marked with the number of amperes which they will safely carry.

The Automatic Circuit-Breaker is a device which may be used in place of the fuse. It automatically cuts a machine out of circuit if the current exceeds that for which the instrument is set.

The Lightning Arrester is used to protect electrical apparatus from damage by lightning. An arrester is unnecessary for an isolated plant, unless the circuit extends out of doors. The Westinghouse arrester is automatic in action, but it should be examined from time to time to see that the connections are tight and the instrument undisturbed.

The Hand Regulator or Field Rheostat is a resistance placed in the shunt field circuit of a machine; in a generator it is used to regulate the voltage and in a motor to regulate the speed. By decreasing or increasing the amount of resistance in the circuit the voltage or speed is proportionately varied. Always start a motor with all its field resistance out.

An Automatic Starting and Stopping Rheostat is used with a shunt or compound wound motor.

It prevents an abnormal flow of current through the armature while the machine is getting up to speed. It is then cut out of circuit.

Should the external circuit be broken the box will automatically cnt in its resistance and then open the armature circuit.

Switchboards.

When desired, we furnish fire-proof switchboards, consisting of marble panels mounted upon an iron frame. They are equipped with our special switchboard apparatus.

The bus-bars and all connections and wires are behind the board, which stands at a sufficient distance from the wall to enable the connections to be frequently and conviently inspected, thus avoiding all the dangers of concealed wiring.

The ammeters and voltmeters are enclosed in handsome non-combustible cases designed to harmonize with the board and other fittings. All connections are made with large surface bearings to avoid heating or waste of energy. The board, as a whole, presents an appearance of elegance and durability which, when our circuit-breaker is used, is never marred or soiled by the "blowing" of heavy fuses, or the breaking of large currents, as with an ordinary switch.